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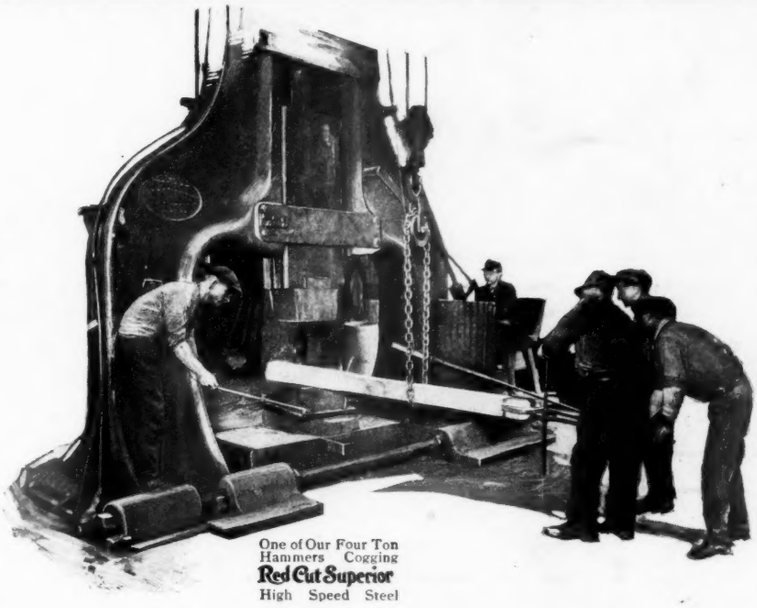

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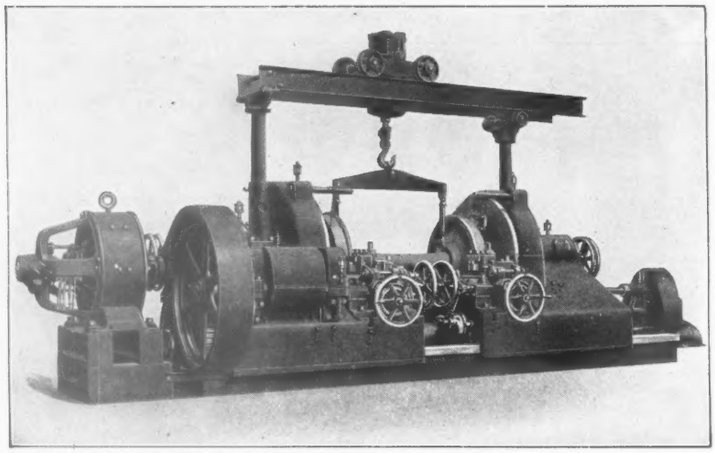

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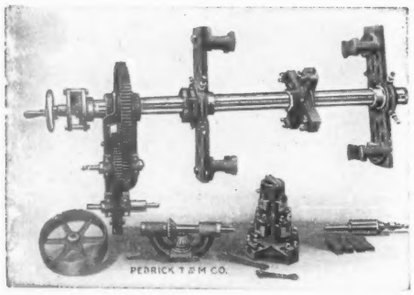

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Railway Mechanical Engineer

Volume 91 March, 1917 No. 3

Milling Machine Practice

In the February issue of the *Railway Mechanical Engineer* an announcement was made regarding the competition on milling machine practice. The field to be covered was purposely made broad enough to permit anyone who is at all interested in the possibilities of this work to contribute. It is our purpose to bring together in a concise form the benefits derived by those of our readers who use this type of machine to good advantage, for the information of those who do not. The milling machine with its various types of cutters has developed very rapidly in the industrial field. It has possibilities in the railway field with which some are not familiar. Some railway mechanical men are seeking knowledge as to its service in railway work. By submitting an article on what is being done on your road you are assisting those who are after this information. You likewise will receive the benefit of the investigations of others who perhaps may have made developments along different lines. Three prizes of $20 each have been offered for the best articles received at our New York office not later than April 1, 1917.

Motive Power Conditions

The remarkable and exceptional conditions confronting the railways during the past winter has put the mechanical departments to the most severe test they have had in years. The demand for engines and the exceptional continuity of the cold weather throughout the winter has been a tremendous drain on the power. Those roads which had their power in excellent condition at the beginning of the winter have weathered the storm with but little difficulty, but those which went into the winter with only indifferent power have found it hard to meet the demands of the transportation departments. Every effort should be made to get the power back into shape as promptly as possible. Indications point to a continuance of heavy business conditions. If the United States enters the war against Germany the probabilities are that the demands on the railways will be still greater. We must be ready to meet these demands. Motive power will be needed and should be made ready. Those who are allowing their power to run beyond its time with the hope there will be a break in business soon are very likely to find themselves in a much worse and perhaps a disastrous condition a few months hence.

Locomotive Rod Job Competition

While the making and handling of locomotive main and side rods are as old as the locomotive itself, but little has been said recently regarding this particular work. In order to bring to the attention of our readers and also to make a matter of record the latest practice in this work, we are offering three prizes of $20 each for the best articles on the rod job from start to finish, which are received in our New York office on or before May 1, 1917. There are three important features to be brought out in these articles, namely, the methods followed in doing the work, the shop facilities for handling the work and the organization of the rod gang. In explaining the methods followed in doing the work, it is desirable that the reason be given as to why any particular method is followed and the advantages accruing therefrom. Under the head of shop facilities should be explained the special devices used for this work and the arrangement of machines and benches in the shop. This will require illustration in many cases. Where blueprints and photographs are not obtainable, sketches capable of being traced will be accepted. In describing the organization of the gang, the duties of each man in it should be clearly outlined. Those contributions which are not awarded prizes, but which are accepted for publication, will be paid for at our regular space rates.

Keeping Standards Up-to-Date

Several years ago an attempt was made on a number of roads to standardize locomotives to secure economy in shop operation and maintenance. It was found, however, that by adhering to strictly standard locomotives, efficiency in road operation was sacrificed, and the designs have been modified from time to time to suit the changing conditions. Many roads are maintaining designs which would not be considered for new power today and which should be altered at the first opporutnity. There are few railroads that do not number among their locomotives some with extremely heavy designs of Stephenson valve gear, which are hard to keep in repair and adjustment. The substitution of an outside gear would, no doubt, save its cost in a short time, yet such changes are seldom made. The application of superheaters to existing equipment is being practiced by many railroads. Some have changed slide valve cylinders for piston valves and the saving has justified the added expense. In car construction the maintenance of the original standards on wooden cars is a fruitful source of expense; the ends and side doors might often profitably be changed, as well as the draft gear. The extent to which the adoption of new standards could be carried and a saving effected thereby, is difficult to determine, but there is no doubt that many roads are neglecting an opportunity for making a considerable saving by rigid adherence to old standards.

Rough Handling of Passenger Trains

Several years ago a great deal of attention was given to the question of handling passenger trains so as to eliminate shocks in starting and stopping. Means were found to reduce the jarring which proved so unpleasant to passengers, and the educational campaign carried on among the enginemen resulted in a marked improvement. Observant passengers will agree that this problem has come back to trouble railroad men again. The introduction of the steel car and the consequent increase in the weight of passenger trains has created new problems in connection with the handling of trains, and it is doubtful whether the methods which produced such good results before will be of any avail

in dealing with the present situation. Passenger trains weighing more than 1,000 tons are not uncommon, and the high starting resistance, when combined with grade resistance, often makes it impossible to start trains without taking the slack. Even where there is no adverse grade to contend with the brakes often fail to release as they should, making it impossible to start a train smoothly.

The situation is certain to give trouble and vigorous methods should be taken to find the source of the difficulty and eliminate the undesirable conditions. Generally fairly smooth stops can be made, the problem at the present time being to do away with the difficulty experienced in starting without taking the slack. The reduction of the frictional resistance of starting by the application of roller bearings is a possible solution, but this will probably not be considered until more attention has been given to the foundation brake rigging. When the problem of rough handling came up before it was successfully met by the road foreman. The present trouble arises from other causes, and the designer and the car repair man must find a way to overcome it.

Railroad Fuel Organization

There are four important items to be considered in any railroad fuel organization which must be handled in sequence in order that the best results may be obtained. Inspection of the coal at mines comes first. Next is the handling of the coal after it has been received by the road; then the education of the employees who use the coal, and last, the facilities and assistance these employees are given in the matter of well maintained equipment to encourage them in getting the most out of the fuel.

It is only by careful and efficient inspection that the proper grade of coal will be obtained from the mines. The inspector is a very important unit in the fuel organization. His duties are broad. He not only must see that the road is receiving the grade of coal it contracts for, but must check the weights, see that the coal is properly loaded in cars, watch the car supply and study the conditions at the mines in order to protect his road against any unforeseen occurrence that may interfere with its regular supply of fuel.

After the road has received its coal properly sized, it must handle it economically and without deterioration. The care with which the inspector at the mines watches the sizing of the coal will be of no benefit if care is not taken to maintain this size while handling it at the coaling stations. The cost of handling and the facilities for unloading the coal from the cars and reloading it onto the locomotive tender is an important matter. Careful records should be kept for comparison and where sufficient coal is handled, a study of the coaling station facilities should be made to determine the most economical method of handling without undue breaking up of the coal lumps. Where modern coaling stations are not used many roads have their coal handled by contractors. Those roads which have well organized fuel departments have found that considerable money can be saved in the cost of handling by operating these stations themselves, and that better results generally can be obtained after the coaling station crews have been carefully instructed. These stations should be under the charge of inspectors whose sole duties should be to see that the coal is properly and economically handled.

In the educational work the employees that handle the coal at the stationary plants should not be neglected. Considerable has been done already to educate the engine crews. Various methods are in effect, such as holding meetings at different engine terminals over an entire system, at which lectures are given and moving pictures displayed concerning the entire subject of fuel combustion. At these meetings the men are encouraged to ask questions or suggest methods by which they think fuel conditions can be improved. While such lectures and meetings are of considerable advantage, the best results will be obtained by road instruction. A sufficiently large number of fuel supervisors should be assigned to instruct the engine crews in the matter of proper firing and general engine operation on the road. A man will learn much faster by being *shown* how to do his work than he will be by being *told* how to do it. More weight will be given the instructor's words when he is able to prove his statements by actual demonstrations. The number of supervisors should be sufficiently large in order that all engine crews may be handled often enough to keep their interest alive in the matter of fuel economy. The supervisor should be as free with his compliments as he is with his criticisms and every opportunity should be taken to impress upon the fireman that proper firing and the economical use of fuel saves his back as well as the company's coal bill.

It is human nature for a man to become discouraged and revert to his old practices, if it is found that he is not being given the proper support in doing that which is requested of him. No matter how perfect the instruction may be or how apt the pupil may be, if the materials and engines with which he has to work are not such that a creditable showing can be made, he is very liable to lose interest in his work. It is of prime importance, therefore, that the engines be well maintained, free steamers, and that care be given to provide the proper and standard grade of fuel. There is no question but that better results will be obtained where engines are assigned to specific crews. Where this is done the crews will take greater pride in getting the most out of the power, and will be more liable to see that their engines are properly maintained, so that they may head the list in locomotive performance. The supervisors of fuel economy can gain the support of the engine crews by co-operating with them in having the engines properly maintained.

Co-operation in Valuation Work

The tentative valuations of a few roads which have now been made public by the Interstate Commerce Commission show that the value of the property under the control of the mechanical department is about 20 per cent of the value of the entire property of the railroads. The total amount involved in this valuation is extremely large and it is important that no item should be overlooked. In most of the discussions of the valuation of the railroads great stress has been laid on the work of the engineering department and but little attention paid to the mechanical department.

The great variety of the material to be valued and the meagreness of the available data on the subject make the work complex and difficult. The railroads in general have never before been called upon to handle a problem at all similar to that presented by the Federal valuation and the development of an effective organization to handle it is a difficult matter. The roads which have completed the work can be of great service to those just starting. The first inspection of the shop and motive power is extremely important and extra care bestowed on it will greatly facilitate the final calculations.

All those concerned in the work should bear in mind that the final result is based upon the "condition per cent" which is determined in this inspection. In the inspection of locomotives and cars particular stress should be laid on the necessity of securing full and complete records of the additions and betterments applied since the equipment was purchased. A search through the mechanical department files will often bring to light records of expenditures which otherwise would have been overlooked and this should be done before the inspection is made. In valuing the shop machinery and tools, the gages, jigs and special appliances which have been built in the company's shops should be carefully appraised. Tracings and blueprints represent a large investment which should not be neglected.

In certain sections of the country the railway mechanical valuation engineers have met to discuss the methods used in doing the work. Such conferences will be of great assistance. For the benefit of the roads whose representatives will not be able to attend meetings of this sort wide publicity should be given to the methods which have been developed for making the valuation of the mechanical department as nearly complete and exact as possible.

Conserve the Shop Forces

For the past year the mechanical departments of the railways have had considerable difficulty in holding and obtaining sufficiently large forces to operate their shops to the capacity the present heavy business demands. Most of the shop craftsmen have been tempted to leave the railroads in response to the flattering offers, which at best are only temporary, of the industrial shops which have benefited by the "war prosperity." Some have accepted these offers while others, preferring the steady work offered by the railroads, have remained. Undoubtedly those that chose the latter course were the wiser. But little can be gained by jumping from place to place even though the wages for a time may be better. The new men in the shop should be made to realize this.

It should be the duty of the shop officers to interest themselves in the personal welfare of the men under them. It should be the duty of every railroad to make the living conditions of their shop men as comfortable as possible. Efforts should be made to make the work congenial for the men and keep them satisfied with their work. Money spent for bringing employees into closer relationship with their employers is well invested. The men should be made to feel that they are a necessary part of the railroad for which they work and that they are a permanent unit in the organization. No shop can be efficiently operated which depends on "floaters" to do the work. The shop men are getting excellent wages and are working full time and many of them are getting considerable overtime. Why not caution them now against overextravagance and encourage them to save some of their money for the proverbial "rainy day." All business has its "ups and downs" and it was but a short time ago that business was decidedly "down." With the proper kind of encouragement the men could be educated to prepare themselves for these depressions. With money in the bank they will be able to tide over hard times with less discomfort and they will be far less liable to drift away from their steady jobs. Missionary work along these lines will not only help the men, but it will also help keep the shop forces intact.

Light Reciprocating Parts for Locomotives

Of the many refinements in locomotive design, that of light reciprocating parts is the one which has been given the least consideration by most railroads. And it is the refinement that, on account of the heavy engines being built at the present time, is deserving of very careful study by all railway mechanical engineers. There is a tendency on some roads to wait a few years in order to reap the benefits of the studies made of this subject by other roads. Still other roads question the practicability of using heat-treated metal in locomotive service on account of the troubles experienced by some roads that have been progressive enough to attempt the use of this material. In either case, however, the "watchful-waiting" road is the loser. It either must use locomotives of light weight at a sacrifice of economy in operation, or it must subject its roadbed and bridges to undue punishment. At the same time it is losing the experience necessary to successfully handle heat-treated steel, which eventually it will have to acquire.

Some roads have been forced into using light reciprocating parts by the engineering department. Abusive treatment of track has led to investigations which have shown that rail pressures above 80,000 lb. are being produced by some locomotives. On other roads the mechanical department has been able to "get away" with engines on which a considerable amount of counterbalance has been left off, simply because it was inconvenient to put it on. On still another road it is the opinion of the mechanical department that the large counterbalance necessary on some engines is responsible for some of its rod failures.

If there is any doubt as to the practicability of the use of heat-treated steel, a study should be made of the automobile industry. The automobile makers have, however, only been able to use this material after careful study and experimentation. Likewise the railroads will only be able to use it successfully after they have carefully studied the methods of treating the steel. At the present time this material is the only means aside from balanced compounds by which the railroads will be able to meet the demands for heavier power without the adoption of a heavier rail section and a general strengthening of bridges. It is the duty of every mechanical department to prepare itself for the use of this material. Much is to be learned on both the theoretical and practical sides and the sooner both sides are mastered, the sooner will the beneficial effects be obtained.

NEW BOOKS

Proceedings of the Twenty-Fourth Annual Convention of the International Railroad Master Blacksmiths Association. Bound in cloth. 200 pages, 6 in. by 8½ in., illustrated. Published by the association, A. L. Woodworth, secretary, Lima, Ohio.

This book contains the papers and the discussions as presented at the annual meeting held at the Hotel Sherman, Chicago, August 15, 16 and 17, 1916. The range of subjects covered is unusually large. A considerable space is devoted to a discussion of carbon and high speed steels and methods of heat treatment. Other subjects treated include flue welding, spring making and repairing, drop forging, tools and formers, frogs and crossings, oxyacetylene and electric welding, casehardening, shop kinks, powdered coal as fuel for blacksmith shops, piece work and reclamation methods.

Proceedings of the International Railway General Foremen's Association. Edited by William Hall, secretary of the association. 148 pages, illustrated, 6 in. by 9 in. Bound in paper. Published by the association, William Hall, secretary, Winona, Minn.

These proceedings are a record of the 12th annual convention of the association held at the Hotel Sherman, Chicago, on August 29, 30 and 31, and September 1, 1916. The general topics discussed were the problems of the car department, counterbalancing of steam locomotives, the classification of repairs and the relation of foremen to the men. There was also a paper and discussion on fitting up frames and binders and laying out shoes and wedges. The methods of counterbalancing locomotives were discussed at length and a variety of topics were taken up under the other subjects.

Official Proceedings of the American Railway Tool Foremen's Association. 140 pages, illustrated, 6 in. by 9¼ in. Bound in paper. Published by the association, R. D. Fletcher, secretary, 6324 University avenue, Chicago.

This year book is a report of the proceedings of the eighth annual convention of the association which was held at the Hotel Sherman, Chicago, August 24, 25 and 26, 1916. The papers presented dealt with the heat treatment of steel, special tools for steel car repairs, devices for reclaiming material, special tools and devices for the forge shop, and the use of grinding wheels in railroad repair shops. The information regarding tool room practice will be found useful by all tool foremen. Many special devices are illustrated and described and there is also considerable general information concerning the activities of the association.

COMMUNICATIONS

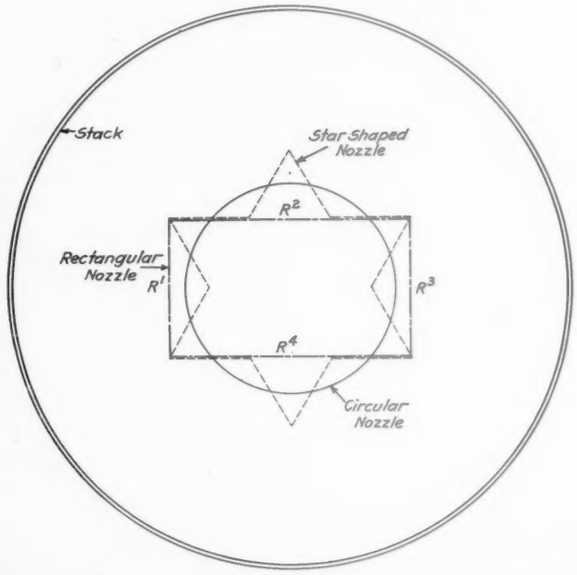
SPECIAL SHAPED NOZZLES: THE REASON FOR THEIR EFFICIENCY

ST. MARYS, Pa.

TO THE EDITOR:

The paper presented to the Central Railway Club at its regular meeting on November 10, 1916, under the title "Fuel Economy and Proper Drafting of Locomotives,"* brought out very forcibly the advantage obtained by the rectangular nozzle over the old style circular nozzle. But a question naturally arises as to whether the improvement has reached its most efficient form.

Referring to the observations made from positions alongside of, in front of, or from the cabs of locomotives of fast-moving trains, in which the exhaust gave the appearance of filling the stack about one-third when viewed from the side, and when viewed from the front or rear seemed to fill the stack to the bulging point; these observations do not appeal to the writer as demonstrating that the round nozzle did not



Stack with Rectangular, Star and Circular Nozzles of Equivalent Areas

fill the stack, but was rather due to the action of the wind resistance and the rapid advance of the locomotive, which would tend to bend the jet as soon as it passed the top of the stack, giving the appearance mentioned. There is no question that well-designed exhaust bases, round nozzles and stacks will cause the stacks to be properly filled, and yet will not meet the theoretical requirements as well as either the rectangular or star-shaped nozzles.

If we examine the drawing showing the cross-section of a stack with a circular, rectangular and star-shaped nozzle having approximately the same cross-sectional area, drawn one over another, we will see quite a difference in the perimeters. The following table brings this out clearly.

	Area.	Perimeter Approx.
Circular nozzle, 6 in. diameter	28.27 sq. in.	19 in.
Rectangular nozzle, 4 in. by 7 in	28.00 sq. in.	22 in.
Six point star nozzle, side of point 2.33 in.	28.00 sq. in.	28 in.

The nature of any gas under pressure is to expand and equalize with any surrounding gas of a lower pressure as soon as it is set free. This is the condition we have in the stack of a locomotive when it exhausts. We know that the circle contains the greatest area for the length of its perimeter, compared with other polygons; therefore, the jet of the circular nozzle will offer the least friction passing through the surrounding gases of the smoke box.

The rectangular nozzle has a perimeter approximately 16 per cent greater than the circular nozzle, which causes the jet to offer a greater friction to the surrounding gases, consequently carrying a greater amount of the smoke box gases with it. Its shape also creates a condition that the circular nozzle does not. By examination of the sketch we will find that the ends *R1* and *R3* of the jet will reach the inside perimeter of the stack before the center of the sides *R2* and *R4* do due to the first two sides being closer to the inside perimeter of the stack, causing a greater mingling of the smoke box gases with the jet, because the sides *R1* and *R3* begin to spread both ways when they come in contact with the stack before the other two sides *R2* and *R4* have expanded enough to come in contact with the stack. The late arrival of the sides R2 and R4 causes the second mingling of the gases with the jet, which has the result of further increasing the velocity of the gases.

We have the same condition with the star-shaped nozzle as we have with the rectangular exhaust, only in this case it has 47 per cent more perimeter than the circular nozzle and 27 per cent more than in the rectangular nozzle, which would increase the jet friction over the other two types, and the star shape has six points to spread and entrain the gases and six depressions to expand which, to a greater extent, would increase the mingling action of the gases in the same manner as explained for the rectangular nozzle.

It has been claimed that the rectangular nozzle has made good and shown a saving in fuel on several railroads, and it is a question in the writer's mind whether this same principle cannot be carried a step farther by the use of a star-shaped nozzle.

E. F. GIVIN.

Mechanical Engineer, Pittsburg, Shawmut & Northern.

*An abstract of this paper appears on another page in this issue.

WHAT IS AN ENGINE FAILURE?

BOSTON, MASS.

TO THE EDITOR:

As a reader of your paper for many years I have been much interested in the several references to engine failures, mileage per failure, etc. I do not recall ever having seen a standard definition of an engine failure.

1. Is failure to make time due wholly to bad coal, an engine failure?

2. Suppose an engine is running perfectly in all respects, but that an extra sleeper or two have been added to the usual train, just enough to make it impossible for the locomotive to haul the train at the timecard speed.

3. Suppose a passenger train arrives at the terminal on time, but with an engine axle so badly heated or cut that it has to be removed.

4. Suppose, in the last case, the axle has been cooled and packed on the road, delaying the train, but causing no damage to engine.

Are all these engine failures?

The above are only a few of the items that might be worth considering in arriving at a more satisfactory definition of an engine failure.

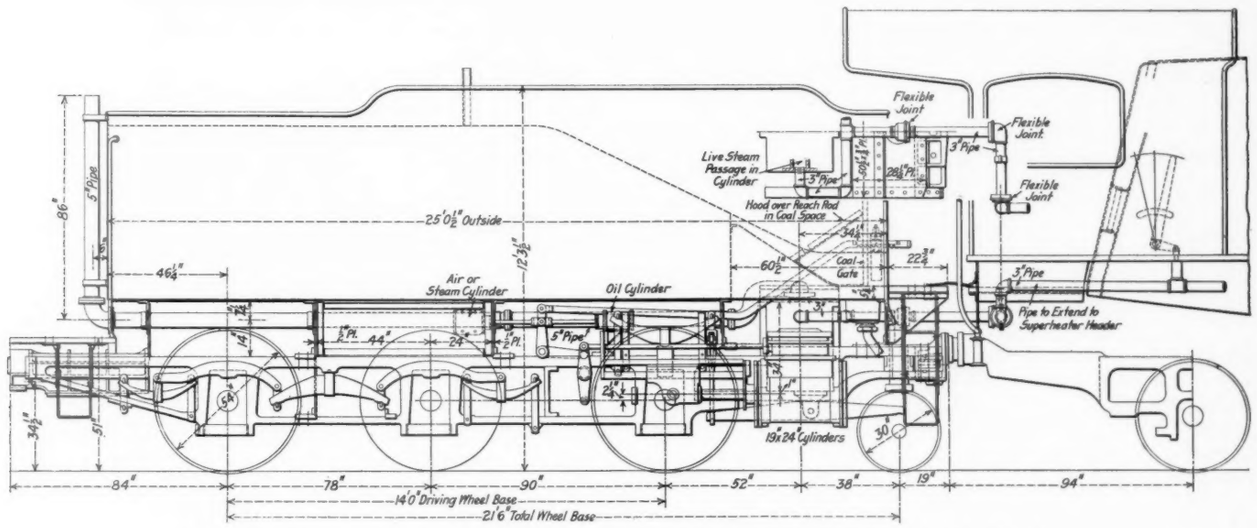
W. J.

SUPERHEAT IN POWER PLANT WORK.—In an article in Industrial Management, Robert L. Struter states that the degree of superheat used in the United States for power plant work varies from 25 to 100 deg. F. for engines and from 100 deg. to 200 deg. F. for turbines. In Europe a superheat of 300 deg. F. is not uncommon.

SOUTHERN DUPLEX LOCOMOTIVES

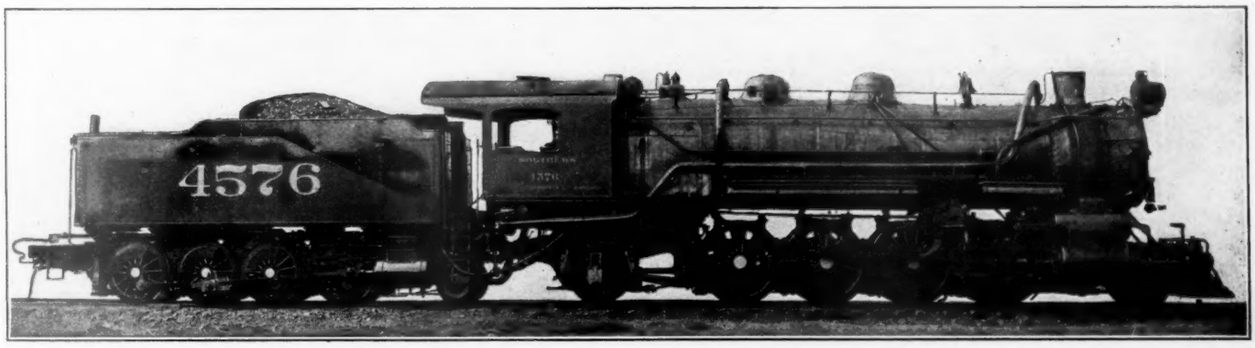
Running Gear and Machinery of Retired Engines Applied to the Tenders of Mikado Locomotives

BY the application of the running gear and machinery of retired Mogul and Consolidation locomotives to the water tanks of existing Mikado locomotives, the Southern Railway has materially increased the capacity of these locomotives without increasing the wheel load and with a marked decrease in fuel consumption per ton-mile. This has been done with but little change to either the running gear of the retired engines or to the water tanks of the Mikados. In fact, it is as though the boiler were lifted from the retired locomotive and the water tank of the Mikados placed on the frame in lieu thereof, the running gear and machinery, together with the cylinder castings and frame remaining intact. The diameter of the cylinders of the tender engine has been reduced, which, with the reduction of one inch in diameter of the Mikado type cylinders, does not overtax the Mikado boiler to any great extent. In addition to the reduction in cylinder diameter, the boiler capacity has been increased by the addition of brick arches and a feed water heater which uses the exhaust steam from the air compressor.



General Arrangement of Mogul Running Gear and Machinery Applied to a Mikado Tender

Steam for the tender engine is taken directly from the superheater header through a well lagged 3-in. pipe extending backward underneath the cab, as shown in the illustration. A second pipe, which permits the added use of saturated steam taken direct from the top of the boiler is also connected with this pipe. This has been added in order to provide greater steam supply to the tender engine for peak loads on heavy grades. The saturated steam supply and the superheated steam supply are controlled separately by gate valves in each pipe, operated from the cab. The steam supply to the Mikado engine itself is also independent of these two sources. The reversing mechanism for the tender engine is controlled from the engine deck, as indicated in the drawings. The reach rod is provided with notches to give full gear, three-quarter gear, one-half gear and one-quarter gear forward, and full gear and three-quarter gear backward. The reversing gear of the tender engine may be operated by any suitable reversing mechanism and, where operated by hand, an air cylinder with an oil cylinder dash pot is used to assist in the movement of the gear. The photograph shows the application of the running gear and machinery of a Consolidation locomotive to the tender, while the drawings show the application of the Mogul type engine to the tender. In either case the details are substantially the same.



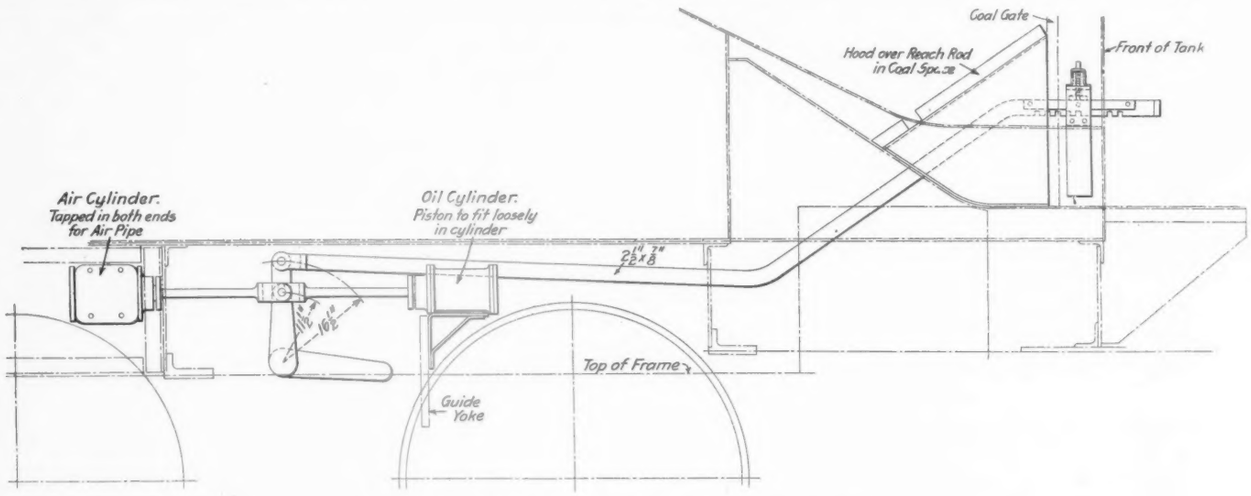
Southern Railway Duplex Locomotive with Consolidation Running Gear under the Mikado Tender

With the application of the Consolidation running gear to

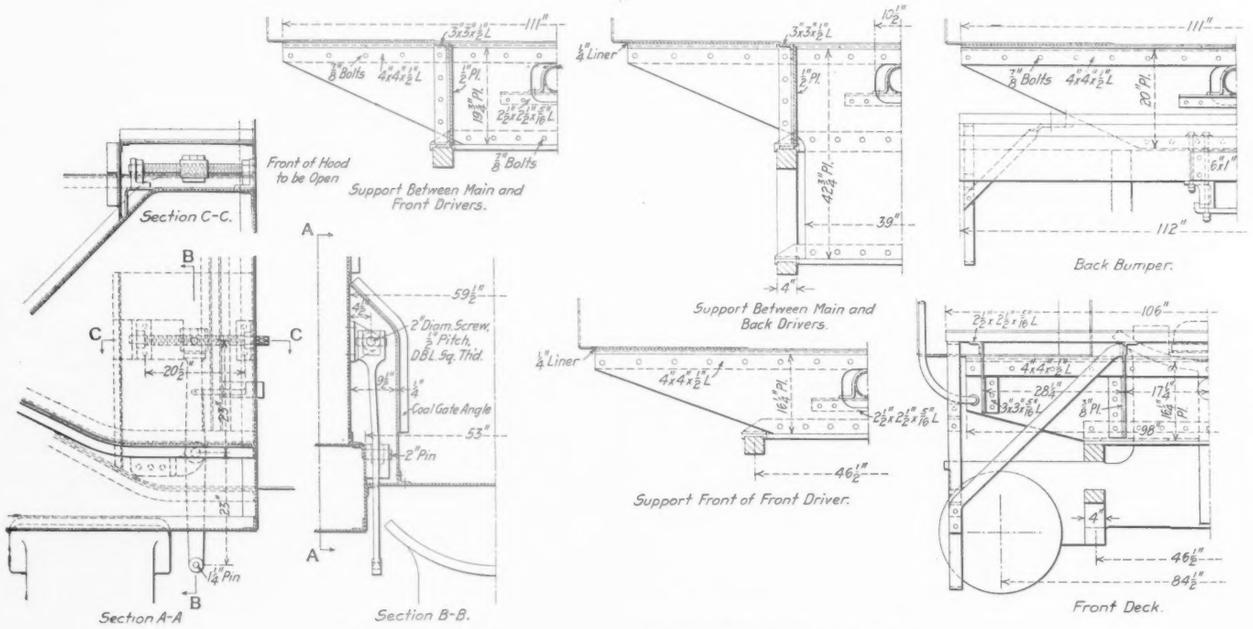
the tender the draw-bar pull of the Duplex locomotives is 39 per cent greater than that of the original Mikados. The locomotive is operated at 175 lb. boiler pressure, which, with 27-in. by 30-in. cylinders and 63-in. drivers in the original Mikados, gives a tractive effort of 51,600 lb. By reducing the diameter of the cylinder to 26 in. the tractive effort of the Mikado locomotive was reduced to 47,900 lb. The tractive effort of the tender unit in case of the Consolidation locomotive, with 20-in. by 24-in. cylinders, and 50-in. driving wheels is 28,600 lb., making a total of 76,500 lb. Tests have shown that the draw-bar pull available from the combination is 64,000 lb., as compared with 46,000 lb. for the single Mikado, or an increase of 39 per cent. It has been found that the maximum draw-bar pull of the Duplex locomotives can be sustained on a continuous pull for 50 min. Several of these locomotives have been installed on the line between Asheville, N. C., and Hayne, S. C., a distance of 68 miles. On this line, eastbound, the heavy traffic direction, there are 1.5 per cent and 1.7 per cent grades. With the single Mikado locomotives the maximum tonnage handled over the first 22 miles of this line is 1,100 tons. The Duplex locomotives will handle 1,400 tons, or an increase of 27 per cent. On this part of the line there is a 1.5 per cent grade for 5 miles, with many reverse curves.

For the remaining distance, 46 miles, there is one short grade of 1.7 per cent with reverse curves and a slow approach which, with other grades of the same percentage but with less curvature, limits the capacity of the single Mikados to 1,150 tons. The Duplex locomotives will handle 1,600 tons, or an increase of 39 per cent. The average for the whole eastbound trip is 77,100 ton-miles for the single Mikado locomotives and 104,400 ton-miles for the Duplex locomotives, or an increase of 36 per cent. In handling this additional tonnage the Duplex locomotives burn substantially the same total amount of coal as the single Mikados, the average for the Mikados being 18 lb. per 100 ton-miles, and for the Duplex locomotives 12 lb. per 100 ton-miles. The engine crews on this line make a round trip of 136 miles in an average running time of from 12 to 13 hours.

The Mogul tender units have 19-in. by 24-in. cylinders

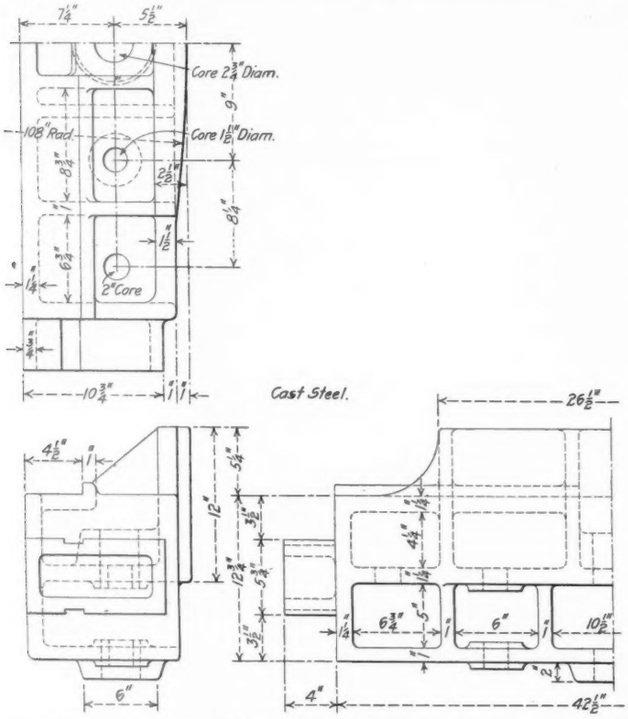

Coal Gate
Hood over Reach Rod in Coal Space
Front of Tank
Air Cylinder: Tapped in both ends for Air Pipe
Oil Cylinder: Piston to fit loosely in cylinder
Top of Frame
Guide Yoke

Arrangement of the Reversing Gear for the Tender Engine



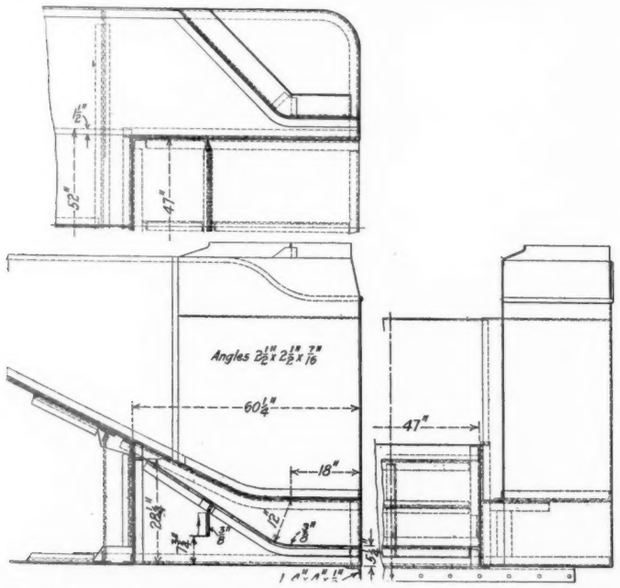
Details of the Tank Supports on the Mogul Type Tender Engine

with 54-in. drivers, which with 175-lb. boiler pressure, gives a tractive effort of 23,850 lb. This, added to the 47,900-lb. tractive effort of the improved Mikado locomotives, gives a total tractive effort of 71,750 lb. In only the Mogul application is the factor of adhesion with the minimum weight of



Front Draw Casting of the Tender Unit of the Duplex Locomotive

tender much too low. In this case, with the tender practically empty of water and coal, a factor of adhesion of only about 2.25 is obtained, while in both cases the maximum factor of adhesion, that is, with the tender loaded, is 5.25.



Front End of the Tank as Redesigned for the Duplex Locomotive

In case of the Consolidation tender unit the minimum factor of adhesion is about 3.25, and inasmuch as this unit is used more than the Mogul unit, but little difficulty is experienced in this regard. The weight of the tender unit with the Consolidation wheel arrangement is 176,000 lb. maximum and with the Mogul wheel arrangement, 152,000 lb. maximum.

The drawings show the application of the running gear and machinery of a Mogul type locomotive to the water tank of the Mikado type locomotive. The entire lower part of the Mogul locomotive remains practically unchanged. The cylinder casting is retained intact and the front and rear draft castings are changed slightly, the front draft casting being shown in one of the illustrations. The upper rails of the frames are 4 in. by 4 in. and the lower rails are 4 in. by 2½ in. The water tank is supported on the frames by five ½in. transverse plate supports riveted to 4-in. by 4-in. by ½-in. angles on the water tank and to frame cross braces at the frames, and by a ½-in. plate support about 5 ft. long on each side of the tank over the main drivers. The fourth transverse plate support extends down to the lower rail of the frame. The 3-in. steam pipe running to the tender engine contains three ball joint connections between the engine and tender to give the necessary flexibility. The exhaust from the cylinders passes through a 5-in. pipe to the rear of the tank. This pipe is clamped at each of the transverse supports by a strap riveted to a 2½-in. by 2½-in. by 5/16-in. angle riveted to these plates.

A pocket is formed in the tank at the front end to provide proper clearance for the rear cylinders, it being redesigned, as shown in the drawings. The Mikado type boiler has a total heating surface of 3,231 sq. ft., with a grate area of 54 sq. ft. The weight on the front engine drivers is 215,700 lbs., with a total engine weight of 272,940 lb. The tank has a capacity of 8,000 gal. of water.

POWDERED COAL FOR BLACKSMITH SHOPS*

BY C. F. HERINGTON
Mechanical Engineer, Powdered Coal Department, Bonnot Company, Canton, Ohio

In spite of the constant demand for increased efficiency in manufacturing, the question of industrial heating, important as it is, is too often lightly considered or overlooked by the management. The B. t. u.s you can buy for a cent does not determine the quantity or the quality of the product you get for a dollar. If the furnaces are so designed as to utilize powdered coal to the best advantage, and the coal dust is economically conveyed and regulated at the furnace to leave no residue of fine particles of coal dust on the work, and the smoke and ash are carried away, a fuel will be had which fulfills everything to be desired.

If the choice of fuels was made on the basis of the heat units they contain coal would surely be chosen, for if fuel oil costs five cents a gallon, coal would have to be $10 a ton to make the cost equal for the same number of B. t. u.s. But this does not by any means measure the comparative efficiency of heating furnaces, for the real problem is one of heating cost and heating efficiency, and not fuel cost. Fuel must be selected which, all things considered, will show the lowest production cost in the shop under prevailing conditions.

Comparing powdered coal with fuel oil and gas on a basis of the heat content, it is found that one gallon of oil costing five cents contains 140,000 B. t. u.s, which is equal to 10 lb. of coal of 14,000 B. t. u.s per pound. Assuming that coal costs $2.50 per ton, and the cost of grinding and distributing it to the furnaces is 50 cents, fuel oil would have to sell at 1½ cents per gallon to make the cost of oil and coal the same per B. t. u. On the same basis natural gas must be bought at 11¼ cents per 1,000 cu. ft., and producer gas at two cents to equal powdered coal at $3 per ton.

In the eastern part of Pennsylvania there has been in operation for a year and a half a powdered coal plant operated on what is known as the Holbeck system. In this system air is

*From a paper presented at the annual convention of the International Railroad Master Blacksmiths' Association.

used as an agent for conveying the coal dust to the different furnaces. The coal is first pulverized in the usual manner and delivered to a storage bin located in the coal building. This bin is the only one in the plant used for storing pulverized coal, and was made of sufficient capacity to serve the furnaces for one day. The powdered coal is taken from this bin by a double flight screw conveyor driven by a variable speed motor. It is then sent into the suction of a high pressure blower, which blows it into the distributing main which carries it to the furnaces through branch lines. The coal which is not used at the furnaces is returned through a return line to a collector located on top of the powdered coal bin. It is extracted from the air and falls into the storage bin where it is used over again. The air from the return line, after the coal is extracted, is returned to the suction side of the distributing blower. Interposed in the distributing main and the distributing blower is a specially designed air indicator and regulator which is used to indicate the flow of air through the system, and to control the feed of powdered coal into the system so as to supply a uniform mixture of coal dust and air to the furnace, regardless of the number of furnaces that are in operation.

With the Holbeck system powdered coal can be conveyed any distance from the coal or grinding plant. The installation mentioned is in a blacksmith shop, and the powdered coal is carried in suspension through pipes and back to the collector, a distance of 2,125 ft. The air and coal dust is carried through spiral riveted pipes, and whenever the velocity is reduced by friction a second, third, or even fourth booster blower is added so that the circulation can be kept for an indefinite distance. No wear is discernible in this piping system.

The advantages of the system are, first, the actual consumption of power for furnishing the coal dust to the furnaces is very low; second, the wear and high cost of repairs incidental to the old method of using screw conveyors is eliminated; third, the storage bin at each individual furnace, which takes up valuable space, is done away with; fourth, within a few minutes after the furnaces are shut off the coal dust is all returned to the storage bin in the pulverizing plant, thus leaving no coal dust in the shops or at the furnaces. In installing this system no large combustion chamber is built, nor are the furnaces changed to any extent. The oil or gas supply is simply cut off and one or two branches of pipe brought down to the furnace with a valve near the main, so arranged that it can be operated from the floor.

SERVICE TESTS OF STEEL SPRINGS

BY GEORGE T. GLOVER
Locomotive Engineer, Great Northern Railway of Ireland

Spring trouble is one which besets many railways on this side of the Atlantic, and there appears to be little record of practical experience in the technical press in regard to methods to overcome the trouble. The Great Northern Railway of Ireland possesses some shunting tank locomotives, shown in Fig. 1 and designed in 1908, which, although of comparative light load per axle, give an undue amount of trouble with spring breakage. The springs shown in Fig. 2 are those under the coupled wheels of 4 ft. 3 in. diameter on tread, and are of a normal British design. They are hung, as shown in Fig. 3, from non-adjustable spring links.

These locomotives have to work on some very indifferent permanent way around the Belfast docks and shipyards, part of the line being laid through public streets in stone setts similar to a tram line, and no system of maintaining the joints at the ends of the rails has been found to give satisfactory results under such heavy traffic, nor will the urban authorities proceed to much expense in maintenance.

No alteration could be made in the design of the locomotives or of the permanent way. Seeing the apparent results of vanadium in certain American motor cars and noticing the constant reference to vanadium steel in the specifications of new locomotives as described in the *Railway Mechanical Engineer,* we determined to give vanadium steel a trial in these springs.

The matter was referred to the Vanadium Company, whose agents supplied springs of the railway company's pattern, but made of vanadium steel of the tensile test and analysis, shown in Table I.

TABLE I

	Ult. stress, tons per sq. in.	Yield point, tons per sq. in.	Elong. in 2 in., per cent	Redn. area, per cent
Normalized	56.8	37.4	17.0	35.0
Tempered (as in spring)	102	96.5	9.0	25.0
Hardened	123 = 578 Brinnell Too hard to grip in test jaws.			

Analysis

C.	P.	S.	Si.	Mn.	Chr.	Van.
.5	.028	.033	.17	.45	.96	.21

The most interesting point to be noted is the high percentage of yield point to ultimate tensile stress, particularly

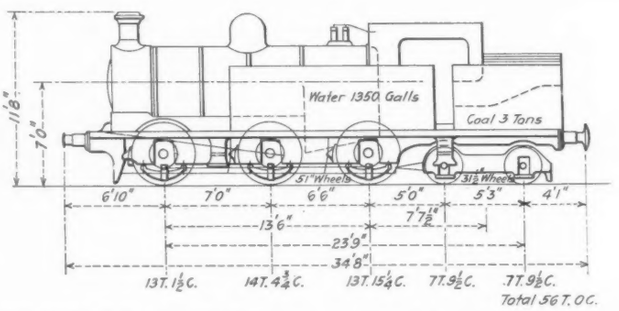


Fig. 1—Type of Locomotive That Was Used in Making Spring Tests

in the tempered state. No details are available as to the tempering, etc., as this was carried out at the maker's works, the springs being supplied complete to drawing and ready for putting under the engines. The springs stood the following loading test, the chief point of interest here being the small range per ton weight and the high elastic limit of the spring, permitting a return to the initial loaded camber after a reversal of camber to 5/8 in. beyond straight:

Tons	0	2	4	6	7½	10	12
Deflection	1 in.	11/16 in.	7/16 in.	3/16 in.	Str.	—5/16 in.	—5/8 in.

The engine springs that were replaced by vanadium steel were made of a good grade of English spring steel; a test

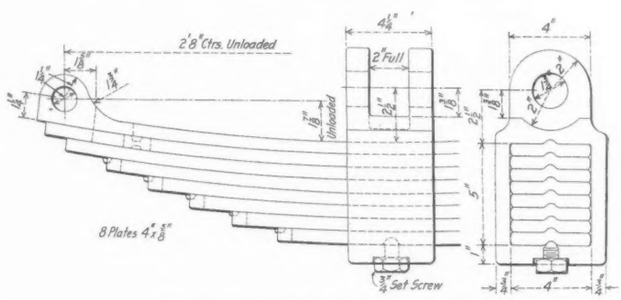


Fig. 2—Type of Spring Under Test

from the normal engine spring made of this steel gave approximately the tensile test and analysis, shown in Table II.

TABLE II

	Ult. stress, tons per sq. in.	Yield point, tons per sq. in.	Elong. in 2 in., per cent	Redn. area, per cent
Normalized	45.2	23.2	19.0	37.0
Tempered	72.6	38.4	2.0	7.0

Analysis

C.	P.	S.	Si.	Mn.
.54	.028	.028	.13	.72

This steel is giving perfect satisfaction in the main line locomotives of the company under heavier axle loads than in the tank locomotives, except in certain cases where these locomotives have to run on a portion of the inferior permanent way mentioned.

There is no reason for adopting the vanadium steel springs all round, as the work of the main line locomotives is confined to the excellent modern permanent way of the company and does not entail movement over the dock lines where spring trouble is chiefly experienced. In addition, adjustable spring gear can be used under the larger wheel of the main line locomotives, as shown in Fig. 4. This gear can not be used on shunting locomotives, due to lack of clearance.

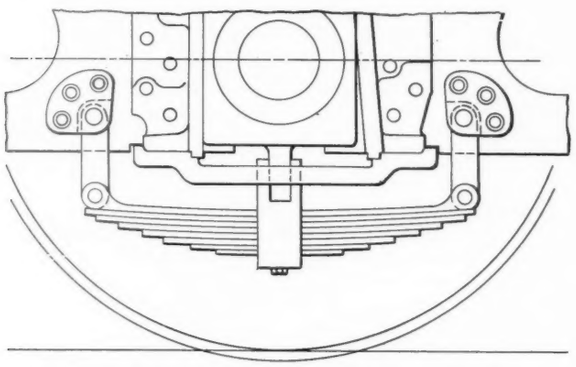


Fig. 3—Test Spring With Non-Adjustable Spring Link

The results to date of the adoption of these springs have been satisfactory in every way and are shown in Table III.

TABLE III—SPRINGS BROKEN

Engine No.	1914 Carbon steel	1915 Vanadium steel
22	37	4
23	44	4
38	25	1
99	29	1
108	29	0
112	23	3
160	42	2
163	13	1
166	20	2
*167	29	6
	291	24

*In this case broken vanadium steel springs were replaced with ordinary steel springs which failed to stand up with the vanadium springs.

In the case of carbon steel springs the repairs to damaged springs were carried out at the company's works, where the

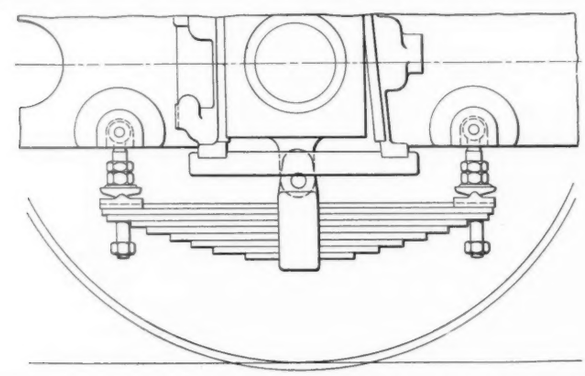


Fig. 4—Adjustable Spring Link Used On Main Line Locomotives

skill and appliances are not equal to the maker's, so that the proportion of about 12 to 1 should be reduced to about 6 to 1, even then the economy is remarkable.

As a test six new carbon springs were put in as from makers in an engine where vanadium had lasted 12 weeks, the new carbon spring failed in 2 weeks, whereas the repaired carbon only lasted one week. In the case of the breakage of ordinary steel springs, as a rule, it involved replacing half the number of plates, whereas in the case of the vanadium steel springs only one or two plates, usually top plates, require replacement.

The vanadium steel springs were supplied at an additional cost of roughly 50 per cent, or £9 for the set of 6 springs—no calculation is required to show how rapidly this is recouped when the changing or repair of defective springs, lifting of locomotive, loss of service of locomotive, etc., is taken into consideration. These prices refer to normal years, such as the early part of 1914.

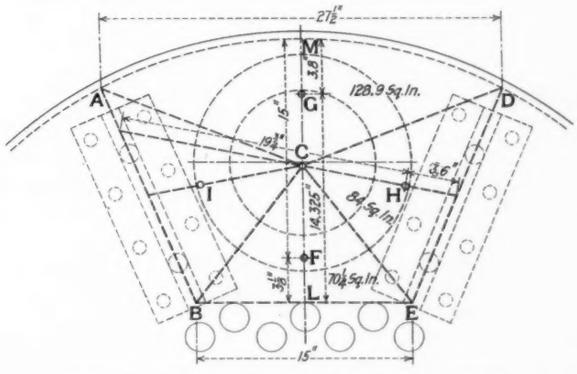
The only slight drawback at present experienced is in the repair of vanadium steel springs, as our shop outfit at the Dundalk locomotive works does not include the pyrometers or furnaces necessary for the exact heat treatment of this steel, and the ordinary methods suitable for carbon steel are not sufficiently accurate; it is, therefore, at present necessary to have repairs and retempering carried out by the spring makers, involving delay and expense in transit.

No difficulties in the repair of these springs should be experienced in the shops of the larger railway companies, where pyrometers, special heating baths, etc., are in sufficient daily requirement to warrant their installation.

LOAD DISTRIBUTION AROUND THE DRY PIPE OPENING OF FRONT TUBE SHEETS

BY THOMAS H. WALKER

There is one flat surface in a locomotive boiler, the load distribution in which is not discussed even in books on locomotive boiler construction. That is of the area about the dry pipe opening in the front tube sheet. The writer has often sought information on this point from others, but without satisfaction. A number of rules-of-thumb have been found in use in various places, but no precise reason for any of these rules could be given. After some consideration the problem was worked out as follows, assuming that the ring around



Analysis of Loads Around the Dry Pipe Opening

the dry pipe hole is heavy enough to transmit the loads involved, which ordinarily will be true.

In the drawing, *A M B* is the inner face of the tube sheet flange, *A B* and *D E* are the center lines of steel T's riveted to the sheet on either side of the dry pipe opening and approximately radial to the flange. The line *B L E* is drawn through the top of the upper row of tubes.

These lines are assumed as the points of support because it is common so to regard them. The writer does not entirely agree with the correctness of this view, but inasmuch as the distribution of the load is not materially affected, it is thought better not to complicate the problem by a discussion of the points of support.

Find the center of gravity of the surface included by *A M D E L B*. With this located at *C*, draw lines from *C*

to *A*, *D*, *B* and to *E*, thus dividing the area into three triangles and a combined triangle and a segment of a circle.

Assume a pressure of 200 lb. per sq. in. over this surface. Then on the triangle *C B E* the load will equal its area, 70¼ sq. in., times 200, or 14,050 lb. If we consider the load as concentrated at *F*, the center of gravity of this triangle, with an adequate support at *C*, it would be distributed inversely as the length of the lever arms *F C* and *F L* on *B L E*. As the center of gravity of a triangle is one-third its height from the base we have an easy method of distributing the load carried. We have, however, no support at *C* but must go 8¾ in. over to *M* to get a support in this direction. The lever arm *F M* is 15 in., while from *F* to *B L E* remains 3⅛ in. Of the total load at *F*, 15/18.125 is on *B L E* and 3.125/18.125 is transferred to the flange about *M*, or 11,627.5 lb. is at *L* and 2,422.5 lb. is at *M*. Considering the triangle *C D E* in a similar way, calling the center of gravity *H*, the lever arms from *H* are respectively 3.6 in. and 19.75 in. long. The area of this triangle is 84 sq. in. and its load of 16,800 lb. is so divided that 14,210 lb. falls on *E D* and 2,590 lb. falls on *A B*. The load on the triangle *A B C* is exactly equal to that on *C D E* and the distribution of the load exactly opposite; that is, 14,210 lb. is carried to *A B* and 2,590 lb. to *E D*.

The area enclosed by *A M D C* must now be considered. Its area is 128.9 sq. in. and its center of gravity *G* is 3.8 in. from *M* and 18⅛ in. from *L*. Of its load of 25,780 lb., 21,313 lb., therefore, rests on the flange and 4,467 lb. rests on the tubes.

The loads carried by the various lines of support are summed up in tabular form. The statement shows that of

Load Distributing Around Dry Pipe Opening:			
A M D	A B	D E	B E
21,313 lb.	2,590 lb.	14,210 lb.	4,467 lb.
2,422.5 lb.	14,210 lb.	2,590 lb.	11,627.5 lb.
23,735.5 lb.	16,800 lb.	16,800 lb.	16,095.5 lb.

the total load, about 32 per cent is on the flange, 23 per cent on either side of the T's and 22 per cent on the tubes. If the tubes are further away than in the case considered the resulting proportion is substantially the same so long as the T's are the same distance apart at the dry pipe center. A case in which the upper edges of the tubes were 4½ in. from the ring around the dry pipe opening instead of 2¼ in., as shown, gave 32½ per cent of the load on the flange, 23½ per cent on each T and 20½ per cent on the tubes.

When the throttle valve is open the steam inside of the dry pipe, being practically under the same pressure as that in the boiler, will balance the load on the area of the dry pipe opening; but when the throttle is closed this is not true and it is manifestly not proper to deduct anything on this account.

The dry pipe, however, being strongly fastened to the tube sheet and anchored at its inner end to the dome and shell, does act as a substantial brace to this portion of the tube sheet, holding it at a right angle to the boiler shell against the deflection which the otherwise unsupported plate would have under the pressure, thus, in effect, transmitting a part of the load which otherwise would fall on the T's or the tubes, up to the flange.

In arriving at the total load on each T, that due to one-half of the area of the next space outside each T must be added to the 23 per cent of the load around the dry pipe opening.

It is of some interest to note that the load carried by the flange above the dry pipe opening is equivalent to that on a surface extending 4½ in. or more from the inside face of the flange.

Some of our lawmakers have decided that 3 in. from the outside of the flange inward is all that any flange can carry. It is difficult to see what we or they can do about a tube sheet flange that will carry more than the law allows. For years it seems to have gone about its business in its own way, regardless of law or lawmakers. It is true that tube sheet flanges crack sometimes—somewhere else. So we suppose we will continue to increase the size of the brace rods,—somewhere else—to compensate for the places where we cannot put them and where no sane and sensible person should want to put them.

MIDWESTERN MECHANICAL VALUATION COMMITTEE

A meeting of mechanical valuation department officers of railroads of the middle West, for the purpose of forming a committee on mechanical valuation was held in Chicago on February 14. C. T. Ripley of the Santa Fe has been made chairman of the committee and W. H. Davis of the Burlington, secretary.

Under the present circumstances there is little uniformity of practice in mechanical valuation in the central and western districts. As each company takes up the work of mechanical valuation, it is necessary for them to do research work alone and to originate methods of organization, handling of field and office work and cost data. Each road has been obliged to take up each problem of the work and deal with it as an individual, although the same question may have been disposed of effectively by some other company in handling its work.

The companies which have finished their work are in an excellent position to assist those which have the mechanical valuation work before them. Some effort has been made to interchange information, but lack of organization has made it difficult. The purpose of the committee will be to discuss the various questions arising and extend the standardization of methods as far as possible. Sub-committees have been appointed to deal with the valuation of locomotives, cars and shops, and to discuss methods of complying with order No. 8.

Some of the subjects discussed at the first meeting were the methods of determining depreciation of locomotives, cars and machinery, scrap values, weighted averages of parts for cars and locomotives, methods of complying with order No. 3, hidden costs in additions and betterments, material in working stocks, methods of making small tool inventory, methods of inventorying work equipment, costs of installation, costs of installing pipe lines, costs of electrical installations, costs of patterns and blue prints, and costs of foundations. The various subjects discussed were assigned to the sub-committees for study.

TRACTIVE EFFORT FORMULA.—The last two equations in Mr. Fry's article, discussing the Kiesel Locomotive Tractive Effort Formula in the February *Railway Mechanical Engineer* on page 70, were incorrectly given. They should have been:

$$\frac{Tv}{Tr} = \frac{2.24}{1 + 0.0092\ B\ V} \quad \text{for saturated steam} \qquad (1\ C)$$

$$\frac{Tv}{Tr} = \frac{2.24}{1 + 0.0077\ B\ V} \quad \text{for superheated steam} \qquad (1\ D)$$

CARS AND LOCOMOTIVES ORDERED IN FEBRUARY.—The purchases of equipment in February were characterized by large and continued purchases of locomotives. January and February have been exceptionally good months from the standpoint of locomotive buying, the orders thus far reported this year having totaled 1,146, of which 780 are for domestic use and 366 for export. The totals for the month were as follows:

	Locomotives	Freight Cars	Passenger Cars
Domestic	623	12,031	199
Foreign	98	9,100	...
Totals	721	21,131	199

The largest purchaser of freight cars during February was the French Government. Several American companies authorized the construction of large numbers of cars in their own shops.

A Study of Boiler Feed Water

The Boiler Itself a Laboratory Where Chemical Reactions Take Place in Feed Water Impurities

BY GEORGE L. FOWLER

IN a recent study of boiler feed waters on a railroad afflicted with a variety of troubles, certain facts and conditions were brought to light that were new to those conducting the investigation, and they may prove of interest to others who find themselves in the same situation.

In dealing with this investigation, the general principles involved will alone be discussed, as a discussion of the remedies applied would be misleading. This will readily be understood as the development of the subject proceeds. Furthermore the several varieties of water and the methods of handling them will be described separately, as if they were different problems and had been worked out independently, although the investigations were carried on simultaneously, and the data secured at one point often threw light on the situation and suggested the treatment at another point.

The one broad and surprising development all along the line was the impossibility of placing full dependence, and sometimes of placing any dependence whatever, on the analyses of the raw water as drawn from the wayside tanks.

The waters encountered were scaling, corrosive, foaming and muddy, with a tendency to corrode in every case except the foaming.

In one case, where a well water had been used, and a treating plant established, so much trouble had been experienced from foaming that the treating plant had been closed and the water abandoned. This was due to the amount of soda that it had been necessary to add in order to free the water from the sulphate scales. The raw water carried so much of the sulphates of lime and magnesia that the soda added to precipitate them raised the alkalinity to a point where the water was too light for use.

With the abandonment of this well, recourse was had to a somewhat muddy river the water from which was used over an entire division. Its analysis showed little variation, from point to point, the average being about as follows:

	Grains per gallon.
Calcium carbonate	2.42
Calcium sulphate	1.53
Magnesium carbonate	.74
Magnesium sulphate	.88
Sodium sulphate	15
Sodium nitrate	.07
Sodium chloride	2.29
Silica	.66
Alumina and iron oxides	.15
Organic matter	.36
Volatile matter	.44
Total	9.69

From an inspection of the analysis this water would not be considered bad except for the scale-forming ingredients, which were not excessive, and the organic matter, which might decompose and form an acid reaction. It did not cause much trouble from scale. The sheets could be kept comparatively clean, except for clusters of scale that formed to a considerable thickness about the crown sheet staybolts. The extent of these formations is indicated in the sketch.

The scale formed in this district was of medium hardness and brittleness and was easily removed from the surfaces to which it adhered by tapping it with a hammer. It would then peel off in large flakes leaving the metal clean. Where the sheets were bare or the scale thin there was no corrision. But where the scale formed corrosion took place beneath it, forming a large pit as shown. The thicker the scale, the deeper was the pit.

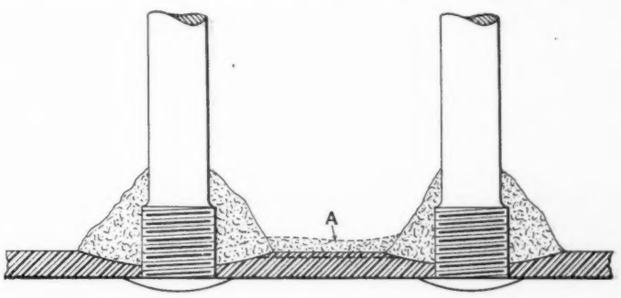
Pitting of the tubes was not as bad at the front end of the boiler as at the rear, the worst condition being found about six feet ahead of the back tubesheet on tubes 19 ft. long. The corrosion was also worse on the top than on the underside of the tubes.

A similar but more pronounced corrosion occurred on the crown sheet at the staybolts. Here, too, it was more pronounced under the thickest scale. The scale formed around the staybolts eccentric with them towards the side of the firebox and almost truly concentric at the center. The slow movement of the water from the side in towards the center apparently was checked by the staybolt and the greater part of the scale deposited here. Occasionally the scale would form on a line from one bolt to the next and then the corrosion would extend between the bolts thus connected, forming a wide groove from bolt to bolt.

As water appeared harmless and the corrosion occurred only beneath the scale it was surmised that the scale might be corrosive. A sample of the scale was therefore analyzed with this result:

	Per cent.
Calcium sulphate ($Ca\ SO_4$)	83.00
Calcium carbonate ($Ca\ CO_3$)	3.96
Magnesium hydroxide [$Mg\ (OH)_2$]	2.88
Silica ($Si\ O_2$)	4.09
Alumina and iron oxide ($Al_2\ Fe_2\ O_6$)	2.99
Combined water and organic matter	1.64
Water driven off at 163° C	1.09
	99.67

As there was nothing in this scale of itself of a corrosive nature, it would seem that after the deposition of a certain amount of scale the plates beneath it become locally overheated. This causes a decomposition of the organic matter, the calcium sulphate and the magnesium hydroxide forming



Scale Formation and Pitting Around Crown Sheet Staybolts

free sulphuric acid which is partially protected from dilution with the boiler water and attacks the sheets.

The cure, then, lies in preventing an accumulation and adhesion of scale. A remedy was applied for this purpose. The scale already formed was broken up, the adhesion of new deposits prevented and, up to the present time, this seems to have stopped the corrosion.

In another case there was little or no trouble from scale, but there was an intense and rapid corrosion that would destroy tubes by pitting in 9 or 10 months.

The water that was doing this did not even give an acid reaction, and though the analysis corresponded to that which was known to have a corrosive action, there was nothing to account for the intensity of the action which actually took place.

A difficulty in making a correct diagnosis of the case lay

in the known probable wide variation in the character of the water drawn from the same tank. Throughout this whole region the water was drawn from small mountain streams that received the drainage from mines and the sewage from villages, and which a sudden shower would raise to overflowing banks.

At one place where there was about 33 grains of scale forming matter to the gallon, of which nearly 30 grains were lime and magnesium sulphates, a lime and soda treating plant had been erected; the results, however, were unsatisfactory. The scale-forming content had been cut down but the soda had raised the alkalinity of the water to the foaming point and engineers had learned to avoid it if possible.

After a rather thorough examination of old analyses of the waters of the region, it was decided that something was happening in the boilers of which nothing was known. Two boilers were selected, the water of each of which had been taken from a single tank, and samples analyzed after having been in service for about eight days. The variation in the composition was startling, as shown by the following analysis:

Impurities	Grains per gallon From tank	From boiler
Calcium carbonate	.29	....
Calcium sulphate	15.05	7.02
Magnesium sulphate	11.67	28.81
Magnesium sulphate (manganic)	....	10.61
Iron sulphate (ferric)	....	43.87
Alumina	....	45.15
Sodium sulphate	9.62	38.38
Sodium chloride	1.52	14.99
Sodium nitrate	....	.12
Silica	1.51	21.93
Alumina and iron oxide	.52	....
Organic matter	1.96	17.21
Free sulphuric acid	....	2.33
Total	42.16	230.42

The water taken from the boiler was extremely bad. The free sulphuric acid, coupled to the large quantity of organic matter, fully explain the rapid corrosion that takes place in the boiler using the raw water from which it is formed. Tubes were fitted and seams cut away in a short time so that the working of the engines became an impossibility.

Because of the uncertainty as to the uniformity of the quality of the water delivered to the boiler, an experimental investigation was instituted. A small boiler of about two gallons capacity was built, in which definite samples of water were evaporated. As first built the boiler was fitted with a gravity feed in which the water was heated before it entered the boiler, and where there was evidently some deposit of scale. The boiler was operated under a steam pressure of 200 lb. per sq. in.

The method of operation was to draw a quantity of water from the tank to be examined, and analyze it; then to take 75 gallons of the sample and evaporate it to one gallon in the small boiler. A typical result is given in the following analyses:

Impurities	Grains per gallon Raw water from tank	Concentrated water from boiler
Calcium carbonate	1.34	.73
Calcium sulphate	....	1.91
Magnesium carbonate	.70	....
Magnesium sulphate	.17	2.76
Magnesium chloride	....	1.74
Sodium sulphate	.52	....
Sodium chloride	.70	2.11
Sodium nitrate	.07	.57
Silica	.58	5.47
Alumina and iron oxide	.29	2.64
Organic matter	.81	2.29
Total	5.18	20.24

These analyses present a good example of the change which has been found repeatedly to take place in water that has been subjected to the high pressure and temperature obtaining in a locomotive boiler.

It will be seen that while some compounds disappear others are formed. In this case the raw water contained neither calcium sulphate nor magnesium chloride and yet both were found in the water taken from the boiler. On the other hand, the sodium sulphate and magnesium carbonate disappeared. The calcium sulphate was probably formed by the decomposition of the sodium sulphate and the passage of the sulphuric acid over to the lime, while the magnesium chloride was probably formed by the decomposition of the salt in the presence of the organic matter and the taking up of the chlorine by the magnesium. The further decomposition of the magnesium chloride formed hydrochloric acid which directly attacked the sheets.

The statement as to the decomposition of common salt (sodium chloride) is thought to be novel and may be incredulously received. Salt has always been considered one of the most stable compounds that would remain unchanged, through all the vicissitudes of repeated dissolving and precipitation by evaporating. In seven cases where these evaporation tests were made, however, each showed an apparent disappearance of the salt and the formation of new compounds that did not exist in the raw water.

Though the evidence is not absolutely conclusive, this phenomenon seemed so well assured that it was considered worth while to attempt to regulate it. One of the worst of the waters was selected and subjected to the boiling test and an examination made, so that the reactions were known. The raw water was then treated with sufficient barium hydroxide to percipitate all of the sulphates as barium sulphate, at the same time in the hope of removing or decomposing the organic matter that appeared to be giving so much trouble. Again a concentration test was made of 75 gallons of the water thus treated, with the following results:

Impurities	Grains per gallon Treated raw water	Concentrated water
Calcium carbonate	1.11	.70
Magnesium carbonate	.11	.05
Sodium carbonate	2.45	69.18
Sodium sulphate	.58	57.87
Sodium chloride	.76	9.91
Sodium silicate	....	2.63
Silica	.53	....
Alumina and iron oxide	.06	.53
Loss on ignition	.40	4.14
Total	6.00	145.01

These results show that while the elimination of the sulphates was practically accomplished the organic matter was not thoroughly removed, and that all of the sodium was retained in solution and combined with the liberated carbonic acid, some of the sulphuric acid and the silicic acid present, thus making the water strongly foaming. Had less barium hydroxide been used more sulphuric acid would have remained; had more been used free sodium hydroxide would have been found in the concentrated water. The results of this test, therefore, were disappointing.

To effect a complete removal of the organic matter a third trial was made in which 15.5 grains of alumina in the form of aluminum cream was added. The desired end was not attained and the failure was even accentuated by the tendency to foam that developed towards the end of the test.

As these waters do not lend themselves to successful tank treatment two methods were adopted to prevent the corrosive action, both of which appear to be working successfully. One is to make an examination of the water in the boiler each day, and prescribe the amount of soda compound that is to be used. The examination requires only five to ten minutes' time and the application is made through a hose attached to the suction chamber of the injector. Enough of the compound is used to maintain the alkalinity of the water in the boiler at .3 per cent, which, while not entirely noncorrosive, is so nearly so as to avoid trouble.

The other and simpler method is to apply a corrosion inhibitive at each washout. If the boiler has been in service

for some time and the corrosion has started it has been found to require three or four applications to stop it. After that the water drawn from the boiler will be clear and free from oxides. Where this treatment is used and the water in addition to its corrosive qualities carries scale-forming matter in any quantity, it is necessary to add a scale preventative to the inhibitive.

In still another case, where the water was drawn from a territory in the immediate vicinity of iron pyrites mines, and the boiler formed a chemical laboratory that made and unmade variety of compounds, one of the regular proprietary boiler compounds was found to possess the qualities needed to cut scale and prevent corrosion, the water flowing from the boiler clear, instead of almost blood red and filled with iron oxides, as when used without treatment.

Finally, owing to the possible error that might have crept into some of the determinations because of the pre-heating of the water before delivery to the boiler, the latter was overhauled. The heater with the gravity feed was removed and a pump substituted so that cold water was delivered to the boiler, within which it received all its heat. A condenser was also added so that all escaping steam could be collected and made available for analysis.

The water selected for the trial was one that had a bad reputation for scaling and corrosion. It was recognized as unfit for boiler purposes in any event and was made worse by being raised with an air lift, thus becoming charged with air and carbonic acid.

Evaporative tests of this water were made and they will be given in some detail to emphasize the reactions that take place in a boiler when working under the pressure and temperature involved in modern conditions of locomotive service, and to demonstrate the probability of the decomposition of the salt by removing, as far as possible, all elements that might lead to error in the results.

The first test was made with the raw water as delivered to the tank by the air lift. As before, the boiler was cleaned prior to the beginning of the test and 75 gallons were evaporated to one gallon. The reason for the selection of 75 gallons as the quantity to be evaporated was because 75 to 1 was about the ratio of evaporation occurring in the boilers in service during the periods between washouts and it was the best approximation that could be made to road conditions.

The results of the test in which the raw water was used are shown in the following analyses:

Impurities	Grains per gallon: Raw water	Grains per gallon: Concentrated water
Calcium carbonate	10.44	2.51
Calcium sulphate	...	48.59
Calcium chloride	...	19.71
Magnesium carbonate	3.15	...
Magnesium chloride	...	23.92
Sodium sulphate	1.45	...
Sodium nitrate	1.75	91.10
Sodium chloride	1.45	67.33
Silica	.35	.29
Alumina and iron oxide	.11	.29
Organic matter	.81	18.84
Total	19.51	272.58

The recovered sediment weighed 1,091.14 grains and with one gram taken for analysis the following results were obtained:

Calcium carbonate and sulphate	76.72 per cent.
Magnesium hydroxides and carbonate	15.48 per cent.
Alumina	2.36 per cent.
Ferric oxide	.64 per cent.
Silica	2.80 per cent.
Organic matter	.84 per cent.
Water	1.06 per cent.
Total	99.90 per cent.

The distilled water collected in the condenser contained:

Totals solids per gallon	.52 grains
Ammonia per gallon	.22 grains
Chlorine per gallon	.58 grains

With this definite data in hand a similar test was made with the same water treated with enough slacked lime to precipitate the carbonates. For this purpose 66 grams (102.85 grains) of slacked lime was added to 75 gallons of water. The precipitates were allowed to settle and the water filtered before starting the test, which was conducted in the same manner as the one already detailed.

The analysis of the treated and concentrated water was as follows:

	Grains per gallon: Treated	Grains per gallon: Concentrated
Calcium carbonate	1.40	7.28
Calcium sulphate	....	5.85
Magnesium carbonate	.40	....
Magnesium chloride	....	3.09
Sodium sulphate	1.11	44.10
Sodium nitrate	1.75	108.85
Sodium chloride	1.40	63.06
Silica	.35	.35
Alumina and iron oxide	.23	.29
Total	6.44	232.87

This test is of especial interest because of the marked chemical changes that took place in both the raw and treated water under the high pressure and temperature at which the evaporation took place. The most remarkable of these changes was the disappearance of the common salt.

In the raw water the salt amounted to 1.45 grains per gallon or 108.75 grains in the 75 gallons, while but 67.33 could be accounted for in the concentrated water and none in the sludge, a loss of 41.42 grains or more than 38 per cent. At the same time the total organic matter in the 75 gallons was 60.75 grains and but 19.68 grains is accounted for in the concentrated water and sludge. Again there was a total of 236.25 grains of magnesium carbonate in the raw water of which none appeared in the concentrated water and but 15.46 grains in the sludge together with the magnesium hydroxide. Finally of the 131.25 grains of sodium nitrate that was in the raw water there was but 91.10 grains in the concentrated water, making a loss of 40.15 grains or about 30.5 per cent. The losses for carbonates are accounted for by precipitation.

On the other hand there was no magnesium chloride or sodium sulphate in the raw water, while there was 19.71 grains of the former and 48.59 grains of the latter in the concentrated water. These compounds must have been built up by the decomposition of other compounds in the raw water.

Attention has already been called to the fact that common salt is one of the most stable of compounds and that it has been considered impossible to decompose or break it down by boiling the water in which it is dissolved, even though carried to the point of saturation with the consequent precipitation. The writer, however, is not aware that investigations have been made as to the effects of the high pressure and temperature obtaining in these tests. The loss of the salt may be accounted for by the breaking down of the organic matter present.

We have seen that there was a decided loss of organic matter and also the development of some ammonia and free chlorine. It is well known that ammonia has a greater affinity for chlorine than has sodium, while magnesium follows closely after sodium. Hence, when the organic matter contained in the water was decomposed with the release of ammonia, the latter attacked the salt and broke it down by robbing it of its chlorine.

The appearance of magnesium chloride in the concentrated water fully explains the corrosive action, for it is broken down with comparative ease and converted into hydrochloric acid that will make a direct attack on the sheets.

The same chemical changes, but of different quantitative values occurred in the tests of the lime-treated water. With this there was no apparent corrosion. This probably may be explained on the basis of a much smaller development of magnesium chloride, thus diluting the corresponding amount of hydrochloric acid developed to such an extent as to render it harmless. The air, too, that was contained in the raw water probably had a direct influence in promoting some of

the changes that took place, especially in furnishing the oxygen for the formation of the magnesium hydroxide found in the residue.

The removal of this air by the lime treatment apparently prevented that formation from occurring in the second test and so made the water suitable for boiler purposes.

These investigations have been discussed in considerable detail because, so far as is known, it is the first time that the solution of water difficulties has been approached in this way.

The difficulty of explaining phenomena of daily occurrence from analyses of the raw water alone indicated the possibility of chemical action within the boiler and the developments seem to have demonstrated that the boiler of a modern locomotive is a chemical laboratory of almost infinite possibilities. The tests suggest that many of the unsatisfactory results obtained from the use of proprietary compounds have been due to a failure to adapt them to this condition.

The results of the investigation have served to convince those engaged in it that there is no cure-all for boiler troubles, and that the individual remedy must be found for each local or regional trouble. Whatever the trouble may be, an effective remedy can be found if the problem is attacked with a proper spirit of patience and thoroughness and the reactions of the water under working conditions determined. It is well to make a careful diagnosis of the disease before prescribing a remedy.

FUEL ECONOMY AND PROPER DRAFTING OF LOCOMOTIVES

BY D. R. MAC BAIN,
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The drafting of locomotives is a subject which has had a lot of attention during the past twenty years, or such a matter, but in the past eight or ten years, during which time the greatest strides in the history of locomotive design and construction have been made, very little attention has been given the matter, everyone doing about as he pleased so long as fair results were forthcoming.

The modern practice of much better proportion of heating surface to cylinder volume than was common eight or ten

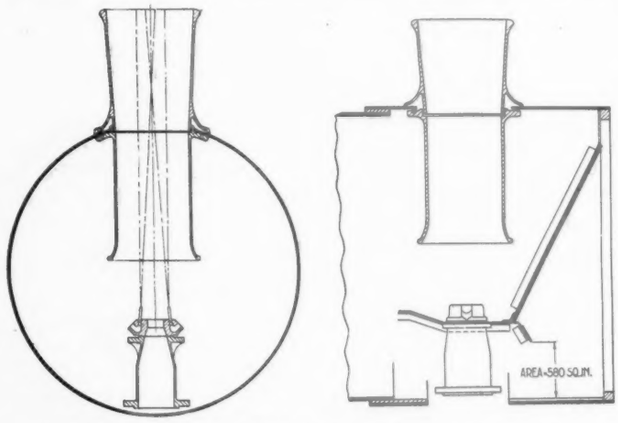


Fig. 1—Standard Front End With Twin Blowers Turned On

years ago has made the getting of steam a lot easier than it used to be, and this fact, in my opinion, is responsible for a very considerable waste of fuel in many instances.

Six or seven years are factors which have lessened the difficulty formerly experienced in making steam at all times and under all conditions of service. In fact, with inferior coal, the locomotive of today, owing to its superior proportion over what used to be common, is a better all around steamer than was the engine of ten years ago, and the addition of superheaters and brick arches has, on the better designs of locomotives and ample boilers, practically wiped out the old alibi for engine failures, such as "poor coal," "dirty fire," etc.

Although we may all be enjoying great freedom from steam trouble at this time, this does not mean that we are producing our steam as economically as it should be done. On the contrary, my own personal observation in riding about the country forces me to the conclusion that the proper drafting of locomotives, with a view of consistent economy, is a subject which for some time has been much neglected and is now in need of serious attention.

Fig. 1 is a cross section of a standard front end, showing twin blowers, with ¾ in. nipples, turned on. It will be noted that the jets from these blowers combine at a point near the top of the stack, but no part of the jet touches the walls. Readings of the vacuum caused by the blower action were taken on locomotives just out of shop with 200 lb. boiler pressure. Vacuum tubes were located in smoke-box in front

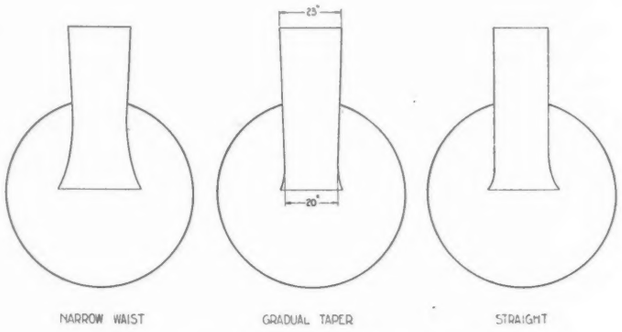


Fig. 2—Types of Smoke Stacks In General Use

of the netting, in the smoke-box in front of the diaphragm under stack, in the smoke-box back of the diaphragm and in the firebox at the center and about 12 in. above the grates.

With one blower turned on full, the readings in the order named were: 1.5 in. of water; 1.45 in. of water; 1.1 in. of water, and .4 in. of water. With two blowers turned on full the readings in the same order were: 2.6 in. of water; 2.6 in. of water; 1.9 in. of water, and .6 in. of water.

This demonstration showed clearly that the steam jet, whether from the blower or the exhaust, does not have to fill the stack in order that draft on the fire may be created. On the contrary, if the jets from the blower were trained on to the walls of the stack the extent of the vacuum would be materially reduced. I believe that a good liberal space around the steam jet at the top of the stack should be provided as an outlet for the induced or entrained gases to pass through to the atmosphere. Certainly if a jet of steam from a blower or pair of blowers, which at the most will not exceed 15 in. in circumference, creates enough draft to overload two 2½ in. pops, a jet of, say, 50 in. to 54 in. in circumference ought to, and does, do all that is needed in the way of creating the necessary draft in a locomotive front end, tubes and fire-box. As indicated in Fig. 1, the area under the deflector is 580 sq. in. The smallest diameter of the stack is 315 sq. in., the largest diameter of the stack 415 sq. in., and when we consider that the same number of cubic feet of gases that pass under the deflector plate each second must, in addition to the volume of the steam jet, pass through the smoke stack in the same unit of time, crowding is suggested. Restricted openings through the smoke stack makes necessary increased exhaust jet velocity, and this is usually produced by reducing the exhaust nozzle. Reducing the exhaust nozzle, at high speeds, especially, results in greater back pressure in the cylinder and decreased engine efficiency is the result.

It would seem, therefore, that if anything can be done to avoid speeding up the exhaust jet in order that sufficient draft

may be had to properly burn the fire, we should give the matter our serious consideration.

Adding the area of the ash pan openings on the class of power we have under consideration we have the following comparison:

Ash pan	750 sq. in.
Under deflector	580 sq. in.
Smallest diameter of stack	314 sq. in.
Largest diameter of stack	415 sq. in.

Is it not possible to decrease the velocity of the steam jet

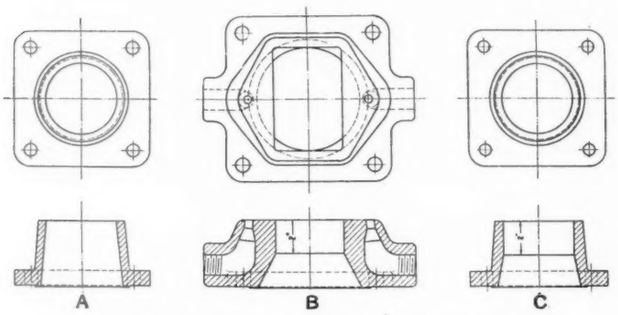


Fig. 3—Rectangular and Round Exhaust Nozzles

by increasing the areas through the smoke stack? I believe it is, and in the course of the evening I hope to demonstrate how it may be done.

Fig. 2 represents the three types of smoke stacks in general use on the power of the present day, the choke or narrow waisted stack, the straight line stack, tapering outward from the bottom up, and the straight stack. There is no useful purpose ever served by the choke, although if the area at the choke be sufficient it probably does no harm.

A gradual taper, in our opinion, is the right idea for a stack. In increasing the diameter from the bottom up it conforms to the outlines of the steam jet as it expands after leaving the nozzle, and affords at the top the necessary free space for the egress of the gases from the fire-box. A straight

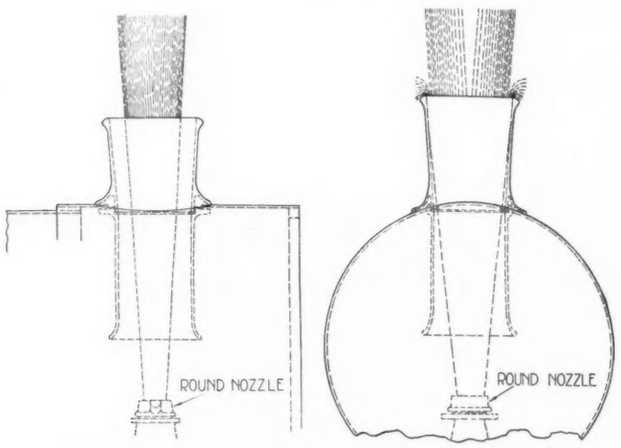


Fig. 4—Action of a Round Exhaust in the Stack

stack, if large enough in diameter, may be placed on a par with one of gradual taper, but my observation has been that this type of stack is almost invariably too small, and is noted most for noise, and this noise costs money.

In Fig. 3 you will note there are two designs of the round nozzle, and one of the rectangular. *A* shows the tapering outlet round nozzle, and *C* the straight bore, or vertical wall, outlet of the same type, while *B* illustrates the rectangular nozzle as now in use on several railroads in this country. It will be noted that figures *B* and *C* have outer walls machined vertically for a depth of 2 inches, while figure *A* tapers inward from its base up. The long inward taper or *A* has no useful function that I can conceive of, so we will confine our remarks to *B* and *C* which have the vertical walled 2-inch outlets, for the balance of the taper.

For a good many years I had observed from my office window, and from positions alongside of the track, when trains were passing at high speed, and when the fire was burnt out clean, that the steam jet in issuing from the stack occupied a comparatively small area of the whole opening, that is to say, the jet seemed to be only about one-third of the diameter of the stack when viewed from the side; while, on the other hand, when viewed from the front or rear, in the latter case from the cab, the jet seemed to fill the stack, to the bulging point, so to speak. The nozzles used when these observations were made were the round type, as shown, *A* and *B* in Fig. 3.

A few years ago I became interested in the subject again through the peculiar action of some large Pacific type engines, with reference to the burning of the fire under certain conditions of service. These engines were of splendid design and of proportions that are today, perhaps, as good as any in the country, and I knew they should make steam freely when the fuel was even fair. For a certain amount of cut-off and a certain length of throttle, at speeds up to 70 miles per hour, they did fairly well, but if they were

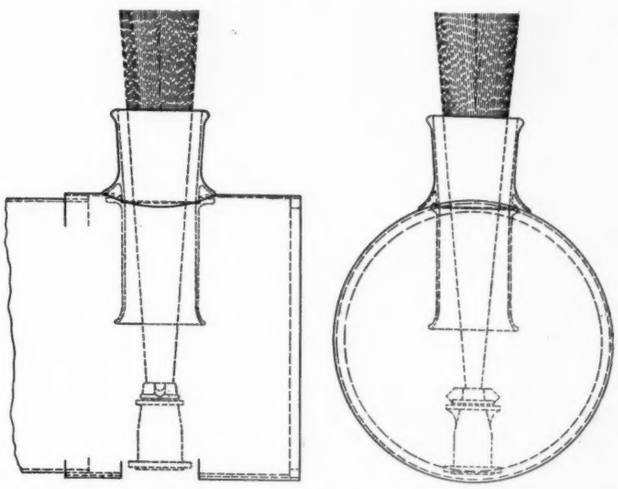


Fig. 5—Action of a Rectangular Exhaust Nozzle in the Stack

crowded either in cut-off or throttle, only a very little, the fire in the fire-box would redden up and the steam pressure would gradually drop back. In other words, these engines, which were equipped with round nozzles, plenty small enough I assure you, limited for themselves the amount of crowding they would stand.

Frequent observations made from the side and the cab developed that the peculiar filling of the stack referred to a moment ago, prevailed even to a more marked degree, especially when viewed from the front or rear, the smoke seeming to roll over the sides of the top of the stack in great volume.

When running slowly these engines shot their exhaust first to one side and then to the other, alternating as the exhaust came from each cylinder, in other words, they cross-fired badly, and this, with other observations made, led me to believe that in this cross-firing lay the cause of our difficulty.

Fig. 4 shows a side and rear view of the steam jet as referred to. You will note in the side view that there is a large amount of space in front and behind the jet, while in the rear view the stack seems to be overfilled and "spilling" over the sides. Our next further thought on the matter was

how we might stop the "spilling" over the sides, which we knew was the result of the cross-firing of the exhaust, as explained, and we set about to remedy the trouble.

First we made a stack 16 in. by 24 in., of sheet iron, and put it on one engine for trial, the long dimension being across the smoke arch. This was done with the idea that the cross-fired exhausts would pass out at the top of the stack without sliding up the sides of same. So far as this feature was concerned, the remedy was all right, but other evils were produced that were even more troublesome than any we had had up to the time this experiment was made, in short, while one side of the wide stack was filled nicely, the other side was very empty, so much so that we had practically no draft on the fire at very slow speed, and very little at any speed.

Believing still that the cross-fired exhaust was the cause of the trouble, and having failed to accomplish anything by letting it pass out of the stack without side friction, our next thought was to try to train that exhaust to travel the "straight and narrow way," as it were.

Our experience up to this time showed conclusively that the stacks were overfilled at the sides and underfilled at the front and back, and a correction of this condition seemed very promising of results.

We were able to fill the front and back satisfactorily by putting a bridge across the nozzle, but we did not remedy

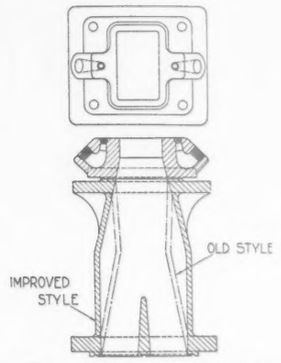


Fig. 6—Rectangular Exhaust Nozzle with Improved Exhaust Pipe

the side condition, nor was there any perceptible improvement in the steam making with the same nozzle opening. Then the thought of narrowing up the steam jet and straightening its course out of the nozzle, suggested a nozzle of the rectangular design.

Fig. 5 is a side and rear view of the exhaust jet after the rectangular nozzle was applied. The nozzle was of greater area than the round nozzles used by about 20 per cent., yet the results were all that could be desired in the way of steam making. The remedy was entirely due to shaping the steam jet so that it did not scrape up the sides of the stack, thereby reducing the induction or entraining area. The change made caused the jet to pass up straight through the stack, leaving the full circumference of the jet exposed to the gases. The result was that the fire burned white when the engine was being crowded, and the full limit of the boiler capacity became at once available.

Fig. 6 shows the design of rectangular nozzle now in use, also the design of exhaust pipe which, in my opinion, gives the best results.

In conclusion, I want to suggest, as a means of decreased fuel consumption and increased engine efficiency:

First: Correct the passage of the steam jet so that cross-firing does not occur.

Second: See that the jet passes out of the top of the stack leaving two or three inches of space all the way around for the entraining or induction of the gases.

Third: Use a plumbing bar in setting of exhaust pipes, nozzles and smoke stacks.

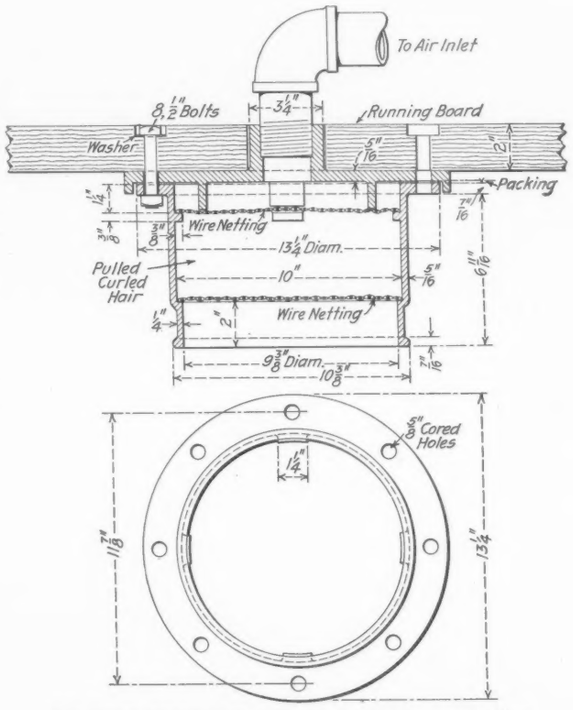
Fourth: Make joints at the bottom of the exhaust pipe and between the exhaust pipe and nozzle tight.

Fifth: If the stacks are too small to allow for the necessary space around the jet at the top, make them larger. I am sure such conditions will bring good results.

AIR PUMP STRAINER

An air pump strainer, the construction of which is shown below, has been developed by the Canadian Northern and is being applied generally to the locomotives of that road. Owing to the extremely low temperatures which prevail during the winter months in the territory through which the Canadian Northern operates, train line leakage is excessive. The simple type of air pump strainer generally used not only considerably restricts the capacity of the air pump to meet the excessive demands upon it, but due to the readiness with which it becomes obstructed in cold weather is dangerous as well.

The strainer shown materially increases the air pump



Air Pump Strainer In Use on the Canadian Northern

capacity by providing a much less obstructed air inlet passage and because of the large inlet area is not liable to become closed with an accumulation of snow and ice. It is simple in construction, may be taken down readily and is so located that the air cylinders cannot be lubricated by pouring oil through the strainer.

The body of the strainer is made up of two iron castings. The top casting is placed underneath the running board and at the center has a pipe boss which extends up through the running board. To this boss is attached the air pump inlet pipe.

The lower casting is filled with pulled curled hair placed between two discs of front end netting, and is held in place by eight ½-in. bolts, which secure the strainer to the running board. The joint between the two castings is packed and there is no possibility of snow or moisture being drawn into the pump, as all air first passes through about 3¾ in. of curled hair, the exposed area of which is sufficiently large to provide against a strong current at the inlet.

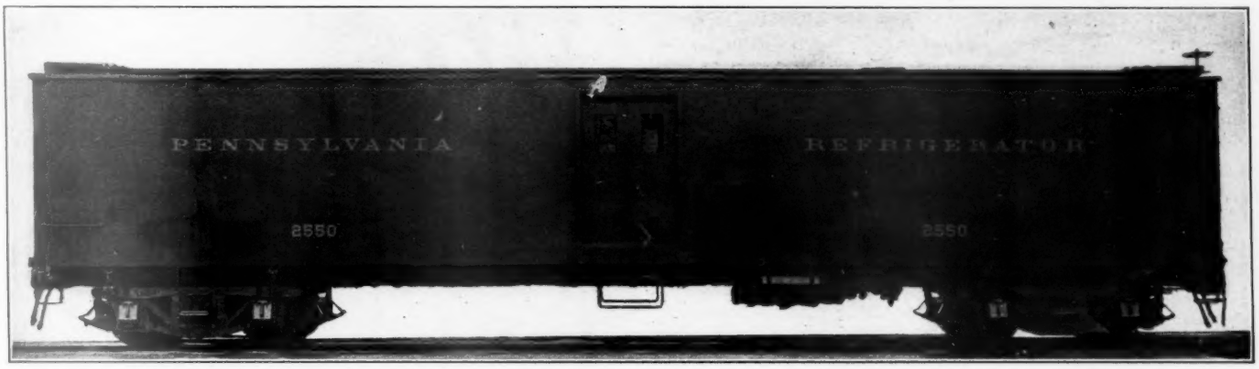
Car Department

PENNSYLVANIA RAILROAD REFRIGERATOR CARS

With a view to utilizing every means available to provide a car which will furnish and maintain adequate refrigeration for milk and cream, the Pennsylvania Railroad has recently designed and built two refrigerator cars which, in many respects, represent a distinct departure from past practices. The cars are designed to use ice either on top of the cans or in the bunkers and are also adapted to the shipment of other commodities than milk and cream.

Past experience and experiments made some years ago indicated the following basic requirements:

1. An inside lining that is watertight and keeps moisture away from the insulation.
2. Adequate continuous insulation fully surrounding the inside lining. The amount of insulation under the roof, which is liable to be heated excessively by the direct rays of the sun, should be greater than that in the sides and bottom.
3. The outside sheathing and roof should be weathertight.
4. The vertical air space around the ice baskets and through the ice should be adequate.
5. The bulkhead, in front of the ice chamber, should be solid, with an air inlet into the ice chamber, close to the ceiling, and an outlet into the car, close to the floor. The bulkhead should be made of non-conducting material, or should be insulated to promote dry refrigeration.
6. The floor should be smooth, to permit sliding the milk cans into place, and to provide a flat base for racks when the car is used for other shipments for which an air space under the lading is of advantage.

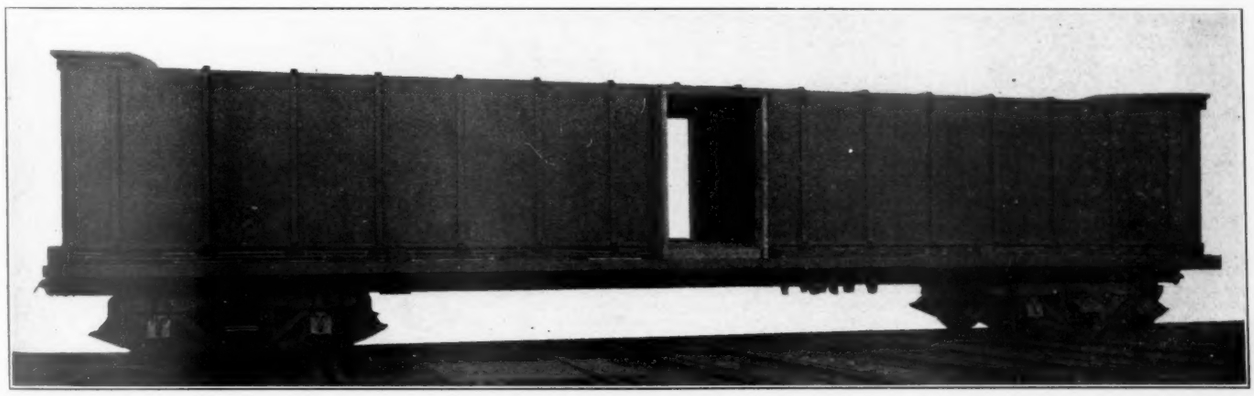


Refrigerator Car With Three Compartments for Rapid Loading

Two cars, differing from each other slightly, for experimental purposes, have just been completed and turned out of the Altoona Car Shops.

Car No. 2500, class R/50, is not partitioned; all of the space between ice baskets is in one compartment. The side doors are of the usual refrigerator type, and open outward.

Car No. 2550, class R/50a, has the space between the ice baskets divided into three compartments, by means of two insulated wooden bulkheads. The middle compartment is 6 ft. 2½-in. long, and is used for quick loading and unloading of cans and boxes from and to station platforms. The cans and boxes can be transferred to or from the other two compartments, which contain the refrigerating means,



Inside Box on Undeframe; Insulation Under Floor

while the train is in motion. In this car the side doors are of light construction, and the insulated refrigerator doors are in the two partitions. With the exception of the differences just mentioned, these two cars are exactly alike.

The trucks are of special construction. The side frames are of cast steel. The side frame center opening, the spring plank, and the 5-ft. 6-in. wheelbase are the same as in freight trucks. The elliptic springs and bolster are the same as used on tenders; the bolster has no side motion. The ends of the frame are arranged for helical springs over the journal boxes and clasp brakes. The axles are of the passenger type, with 5½-in. x 11-in. journals, and the wheels are rolled steel, 33 in. in diameter. The journal boxes are pedestal type passenger car boxes. From this it will be seen that the

Side of Truck, Showing Spring Arrangement and Clasp Brakes

truck represents a combination of passenger and freight truck features.

The underframe also combines passenger and freight principles. Bolsters have been omitted, and cantilevers to support the side bearings have been substituted. The load is carried on the end sills and crossbearers, whence it is transferred to the center plate through the center sills. The center sill construction is of the box type, consisting of two 15-in., 40-lb. channels, spaced 12⅞-in. apart, and two ½-in. by 20-in. coverplates. The side sills are 3½-in. by 5-in. by ⅜-in. angles. The spaces between the center sill coverplate and the side angles are covered with ⅛-in. steel plate, reinforced with U-shaped stiffeners, riveted on top. The back follower stop and front bumper castings are of the integral type used in freight cars. The center plates are drop-forged steel.

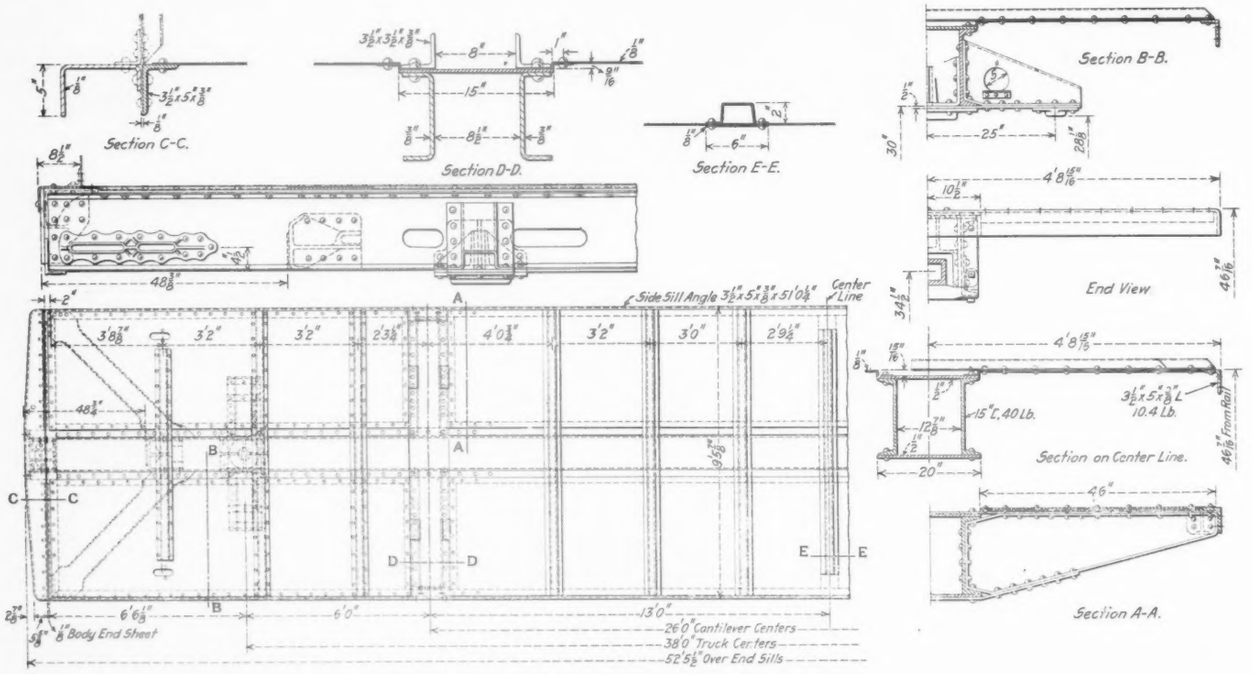
Oak blocks are placed on the end sills and crossbearers to support the steel box forming the inside lining. The spaces between these blocks are filled with insulation, consisting of four layers of ¾-in. Keystone hair felt, separated by wooden grids to form air spaces.

The inside lining consists of 3/16-in. floor plates, ⅛-in. side sheets and 3/32-in. ceiling sheets, all reinforced with U-shaped braces riveted to the outside. It forms a box which can be built up complete on the floor and then lifted to its proper location on the oak supports. The ¾-in. Keystone hair felt, of as great width as can conveniently be manufactured and cut to the proper length, is then lifted to the top of the lining box and unrolled to drop down the sides to meet and join the insulation under the floor. A continuous blanket is thus formed all around the inside box. There are four such blankets running transversely, separated with wooden grids, made of ½-in. strips of soft wood. Two additional layers, separated with wood grids, are placed longitudinally on the top of the box, and four layers are placed at the car ends to correspond with the sides.

Truck Which Combines Passenger and Freight Features

The Keystone hair felt referred to consists of ¾-in. hair felt placed between two sheets of 90-pound specification paper, and securely sewed together.

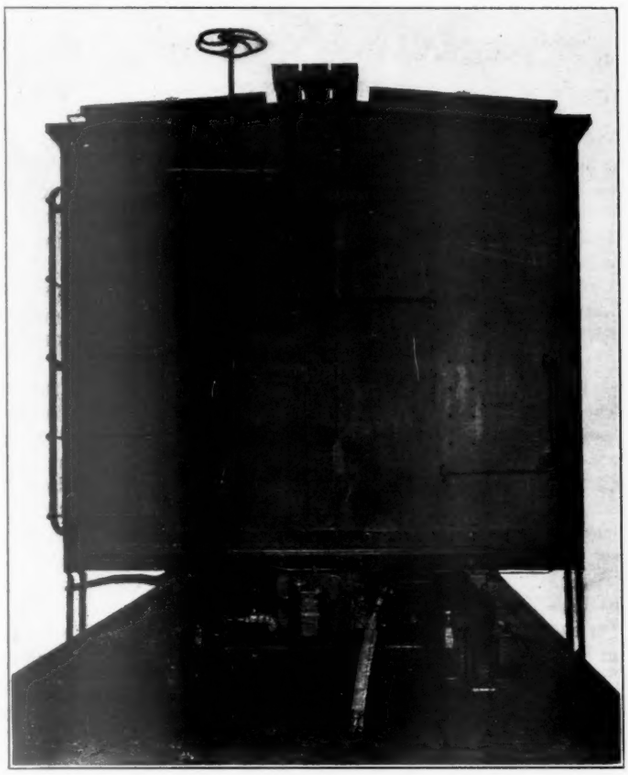
After the insulation has been applied, the sides, ends and roof are attached. These parts are also reinforced with



Underframe of the Pennsylvania Refrigerator Cars

U-shaped braces, and are so designed that the riveting can all be done from the outside. This also permits removing a side, end or roof, for repairs, without disturbing any other part of the car. The connections between inside and outside steel shells are wood. The drains are made of indurated fibre. Hence there are no metal connections between the inside and outside steel shells.

The ice baskets are of the same construction as now standard on other Pennsylvania Railroad refrigerator cars, the



Hand-Brake End of Refrigerator Car

bulkhead in front of each ice basket being made of two courses of wood with an air space between them.

The general dimensions follow:

Length over inside sills	52 ft. 5½ in.
Length between ice chamber bulkheads	42 ft. 8¼ in.
Width over sheathing	9 ft. 6⅛ in.
Width over roof	10 ft. 0⅜ in.
Width inside	8 ft. 5⅝ in.
Height inside (average)	6 ft. 9¼ in.
Weight of car, empty (lb.)	78,000
Ice capacity of baskets (lb.)	10,000
Loading capacity (lb.)	50,000
Loading capacity (cu. ft.)	2,450
Distance between centers of trucks	38 ft. 0 in.
Total wheelbase	43 ft. 6 in.

DESIRABLE FEATURES FOR GOGGLES.—In Technical Paper 102, published by the Department of the Interior, J. A. Watkins, of the United States Public Health Service, enumerates the following features as desirable in goggles intended to protect the eyes from the injurious effects of intense light: 1—Should shut out harmful rays. 2—Reduce the retinal image to a safe brightness. 3—Not unduly hinder vision of other objects besides those on which the employee is working. 4—Be light in weight, well fitted and as comfortable to wear as possible. 5—Have no metal parts that touch the skin. 6—Be fitted with a flange back of each lens so as to prevent glass from entering the eye in case the lens is broken by flying objects. 7—Be of such coloring that color perception is not unduly disturbed.

THE HOT BOX—ITS CAUSE AND CURE*

BY J. F. LEAKE
Chief Joint Inspector, Chattanooga, Tenn.

The principal causes of hot boxes, in my opinion, may be classified under the following heads: (1) Lack of lubrication. (2) Rough journals. (3) Bad journal bearings. (4) Overloaded cars. (5) Trucks out of alinement. (6) Lading improperly distributed.

(1) Improper lubrication is due largely to the packing getting hard and clammy and falling away from the journal, thus cutting off contact between the oily waste and the journal; the result is inevitably a hot box. To eliminate this cause for hot boxes, good material should be furnished. Wool waste is the best because of its elasticity. Capable and honest men should be used. Most roads depend on the oiler solely to do the inspecting of oil boxes, journals and journal bearings, and the necessity of good men is obvious. I have known instances where old men were used simply because they were not able to do other work. The disposition to keep old men at work so they can earn something in their declining years is commendable; however, I am of the opinion that the men who watch and keep the packing in a box so it will come in contact with the journal, should be honest, capable and in possession of all their faculties. Especially would I emphasize eyesight.

(2) Rough journals may result from seams in journals, due to flaws in the metal, which will develop after the journal has been in service for a time; also cut journals usually caused by hard spots in bearings. When journals become thus defective no amount of brassing or lubrication will overcome the trouble. Hot boxes are the result and the wheels must be removed or the journals dressed before the trouble is overcome. To prevent defects of this nature, the service of an expert oiler will be required—one who can determine when a journal requires attention before it reaches the point of causing a hot box.

(3) There are two reasons why a journal bearing will cause a hot box. One is the fact that it has been allowed to run too long before removal. The other is because of bad alloys in the metal which result in hard and soft spots causing uneven wear. A journal bearing in this condition, or one that has been allowed to wear thin and become distorted or broken, will cause journals to run hot. Here again the expert oiler is required, as he should be able to say when a bearing should be removed, or report on a lot of bearings that are giving trouble, so the test department can locate the exact cause.

(4) Overloaded cars cause a great many journals to run hot. The remedy is living strictly up to rules and instructions with regard to weighing and properly handling overloaded cars.

(5) Trucks out of alinement will cause journals to run hot, and may be eliminated by insisting that the inspectors see that the trucks are kept squared up and are running properly.

(6) Improper distribution of lading should be watched by inspectors. Cars found with lading unevenly distributed should be held for correction. This trouble is more often experienced with baggage cars.

The chief inspectors and the train crews especially should keep in touch with each other so that each may keep posted as to the cause and handling of hot boxes on the road. Generally the last man hired on train crews is the one who handles the hot boxes. He furnishes information on which reports are made to the superintendent. These reports go to the master mechanic and finally find their way to the oiler, sometimes with awful force. I have known good and loyal men to be relieved of their jobs because of persistent reports

*Entered in the Hot Box competition, which closed on October 1, 1916.

from train crews; hence the necessity of co-operation and correct information.

Summarizing, we must have good packing. We must have reliable men to apply it and report conditions. We must have intelligent co-operation between the different departments. When this is done, we shall have made great strides toward eliminating the hot box and its resultant dangers.

SUGGESTIONS FOR A CAR DEPARTMENT APPRENTICE COURSE*

BY J. H. DOUGLAS
Freight Foreman, Wheeling & Lake Erie, East Toledo, Ohio

Because of the rapid development in the construction of freight carrying equipment and the efforts of car department officers to design and get into service a car from which maximum service with minimum expense for repairs may be expected; also because of the enormous expense involved in shop machinery and equipment to bring about ideal conditions in freight transportation, the need of a car department apprenticeship course whereby young men may be given a thorough training in the details of car construction and maintenance is daily becoming more imperative.

The car department apprentice should be a young man having at least a high school education. At the start he should be given light repair work. After possibly one year in this service he should be transferred to the heavy repair shop for a like time. At this time the apprentice should be in a position to know the weak points in the average freight car and to know the practical side of repairing cars. He should then be placed in the transportation yards for about six months as an inspector where he could learn how the defects are caused and also just what service is expected of the different classes of cars. After his yard training he should be placed with a good reliable inspector at some interchange point where he could obtain a full and comprehensive knowledge of handling cars in interchange, as well as a thorough understanding of the Master Car Builders' rules. The time spent in this work will depend entirely on the apprentice himself; some will grasp the situation and learn to apply the rules more readily than others, but a general idea of this particular feature of car department work must be obtained before the apprentice is ready for the next step.

The apprentice should then be given a six months' course at the bill desk in order that he may become thoroughly posted as to the actual manner in which bills are rendered and also to become conversant with the kind of information required of the shops and repair tracks before proper billing is possible. The drafting room should be the next step and here the apprentice should be allowed to develop any ideas he may have thought of during his previous training. In the drafting room he can familiarize himself to a great extent with the technical features of car construction and during this time different designs of cars and the Master Car Builders' publications should be studied. The reading of railway magazines should also be encouraged,—in fact, everything should be done to familiarize the apprentice with different designs of draft gears, trucks, underframes, etc., as well as with the details of car construction. After serving such a course, the apprentice should be ready for the position of foreman and should be equipped to accept promotion as fast as the opportunity presents.

The necessity for such an elaborate course may be questioned, but anything that will tend to solve the problem of keeping the cars in serviceable condition should be welcomed by the managers, and the expense involved in such training will be money well spent. The locomotive department men of the different railroads saw years ago that it was necessary to train men to take care of the locomotives, and it appears that the car department men are also awakening to the fact that such a course is necessary to insure efficiency in handling cars.

An enormous amount of money has been spent by the railroads in the last 15 years for the purchase of new cars and a small percentage of this amount carefully expended in the training of employees to fit them for the various callings in the car department will be an investment which will produce dividends.

* Entered in the Apprentice Competition of the Chief Interchange Car Inspectors' and Car Foremen's Association and presented at the annual convention, Indianapolis, Ind., October 3, 4 and 5, 1916.

THREE REASONS FOR HOT BOXES*

BY A. L. BARTZ
Road Foreman of Engines, El Paso & Southwestern, El Paso, Texas

Hot boxes are caused by excessive friction, due to too much weight on bearings; improperly fitted bearings; or lack of lubrication. They may be overcome by preventing a car from being overloaded; by properly fitting the brasses on the journals, and by giving more attention to the lubrication of the bearings.

The mechanical defects most noticeable on new cars are improperly fitted bearings, due to a rough journal and rough babbitt on the brass, or the journal being too small for the weight resting on it.

The mechanical defects on old cars are in nearly all cases the same, except for a sprung truck frame, sprung or rough journals and improperly fitted bearings. As a rule hot boxes are caused by carelessness in neglecting to look after the mechanical defects, and also carelessness in packing the boxes. Employees should receive instructions from the general car foreman on how to pack boxes. The latter should receive a report daily as to the number of hot boxes and the causes, if possible. This will give him a chance to remedy the trouble by locating the real cause.

One cause of a loss of oil is allowing soggy waste to remain in the box, and continually putting oil on top of it, which only runs to the bottom of the box. Oil is also wasted by allowing the boxes to run with defective dust guards and defective box covers. As a rule 75 per cent of the waste and oil in a box is a total loss whenever it is necessary for trainmen to pack a box, as the old packing is allowed to remain on the right of way.

Bearings should be fitted properly and then checked every six months, or at the same time the triple valves are cleaned. The stencil on the auxiliary would show when the boxes are to be packed. After a bearing is fitted properly—the babbitt being of a smooth surface and in first class condition—the car repairers should be very particular to prevent any dirt or waste getting between the bearings, or between the wedge and the brass, which allows the weight of the car to rest on only part of the bearing and leads to a hot box.

Boxes which run satisfactorily should be oiled every 300 miles. If it is necessary to repack a box, take out all the old waste, wash the inside of the box, and use good spongy waste saturated in oil. Roll a large piece of waste and force it against the dust guard; then press enough waste between the journal and bottom of the box to keep the waste against the journal. The packing should not extend above the center line of the journal. There is no need of extra oil being put on top of the new packing in a newly packed box.

In a cold climate hot boxes are often caused by the packing freezing in the box; as soon as the car is moved the journal forces the packing out of the box, and the journal is bound to heat after running a short distance. To prevent this put hot oil on top of the packing before the car is moved. Most of the hot boxes could be avoided if the oilers were more careful and examined the old brass and journal, as in most cases the reason for heating will appear on the brass.

*This article was entered in the Hot Box competition, which closed on October 1, 1916.

FREIGHT CAR REPAIR PROBLEMS*

A Study of Some of the More Important Failures to Freight Equipment and Methods of Repairing Them

BY LEWIS K. SILLCOX
Mechanical Engineer, Illinois Central

ONE of the broadest and most exacting problems facing the mechanical departments of all roads at the present time is that of repairing and rebuilding freight cars. To handle this problem to the best advantage it is very desirable to obtain a definite record of the failures of the various parts of the equipment. It is also desirable to know the percentage of bad order cars located on the road and the output from each shop. The form shown below gives a concise outline of the information desired. It will give exactly the condition of each shop, the type of equipment held, the relative output and the status of the case for the whole system compared with the previous day and the year previous; all of which shows at a glance the general over-all condition of affairs.

DAILY STATEMENT OF CARS IN BAD ORDER AND ON HAND REPAIRED

Date.....

	Division No. 1			Division No. 2	Division No. 3
	A-Station	B-Station	C-Station		
Box—Held today					
Repaired since last report.....					
Furniture—Held today					
Repaired since last report.....					
Stock					
Refrigerator					
Fruit					
Flat					
Coal (Wooden)					
Coal (Steel)					
Coal (Composite)					
Caboose					
Work					
Foreign					
Totals—Loaded today Empty.....					
Totals—Loaded Last Empty Report					
Totals—Loaded Last Empty Year..					

Per Cent of Total Cars Owned to those in Bad Order.....
Per Cent of Total Cars Owned to those Repaired.....

There are two other reports that can be used in connection with this subject, one being a monthly statement showing the failures to freight cars according to their series and the other showing at what points the failures occurred. These reports will give a comprehensive idea of what obtains in service, but most interesting of all, it gives a very concise form of comparison as between one month or year and another. The car parts to be listed in these statements are given in the table.

CAR PARTS TO BE LISTED IN THE FAILURE REPORTS

1. Friction Draft Gear.
2. Spring Draft Gear.
3. Uncoupling Attachments.
4. Body Side Bearings—Flat Type.
5. Body Side Bearings—Roller Type.
6. Truck Side Bearings—Roller Type.
7. Truck Side Bearings—Flat Type.
8. Body Bolster—Cast Steel.
9. Body Bolster—Built Up.
10. Truck Bolster—Built Up.
11. Truck Bolster—Cast Steel.
12. Body Center Plate—Cast Steel.
13. Body Center Plate—Drop Forged Steel.
14. Truck Center Plate—Drop Forged Steel.
15. Truck Center Plate—Cast Steel.
16. Journal Boxes.
17. Air Brake Apparatus—Brake Beams—Heads—Fulcrums—Hangers, etc.
18. Coupler.
19. Coupler Yokes—Wrought Iron.
20. Truck Lateral Motion Device.
21. Coupler Centering Device.
22. Truck Spring Plank.
23. Truck Side Frame—Cast Steel.
24. Truck Side Frame—Built Up.
25. Truck Side Spring—Arch Bar.
26. Drawbar Striking Plate.
27. Center Sill—Steel.
28. Draft Sill—Steel.
29. Truck Bottom Connection Rod
30. Truck Brake Hanger.
31. Truck Column Casting.
32. Truck Spring.
33. End Post Steel.
34. Steel Ends.
35. Drawbar Yokes—Cast Steel—Friction Gear.
36. Drawbar Yokes—Cast Steel—Spring.

REINFORCEMENT FOR WOODEN FRAME CARS

A typical failure of a striking block is shown in Fig. 1. This is bound to occur where there is a large amount of eccentric loading and the blow is delivered at the horn of the coupler. One road reports a suggested method of wooden bracing between the striking plate and body bolster as shown in Fig. 2.

Refrigerator cars require an especially rigid structure which may be obtained by a series of cross bracing in the roof with 2½-in. by ¼-in. material. One large system has applied such bracing using five sets throughout the length of the car. The hatch was also reinforced by a malleable iron metal

Fig. 1—Typical Example of Striking Block Failure

*Abstract of a paper before the Car Foremen's Association of Chicago.

framing which not only keeps this section of the roof from warping but protects it from damage at the time of icing.

One large road in the Northwest is following the practice of reinforcing their roofs as described, except that 2-in. by 6-in. wooden diagonal tie members are used and bolted into place.

The matter of end frame reinforcement is receiving a great deal of attention. One large Eastern road is applying two pressed steel bellied U-braces to the end sheathing over the end posts, a tie rod through the side plates and end plates, angle plates at the belt rails inside and outside of the car in each corner, a 2½-in. by 2½-in. by ⅜-in. angle at the end of the side and end plates, a tie rod through the ends just above the belt rail and 1¾-in. flooring to the end lining for about 3½ ft. up from the floor. The angle iron at the side and end plates is in one piece, extending about 4½ ft. along each side plate. It spans each of the corners to avoid sharp bends and is securely bolted to both the end and side plates.

Another road is applying 4-in., 8.2 lb. Z-bars at each end post, 4-in. by 4-in. by 5-16-in. angles at the end plates and

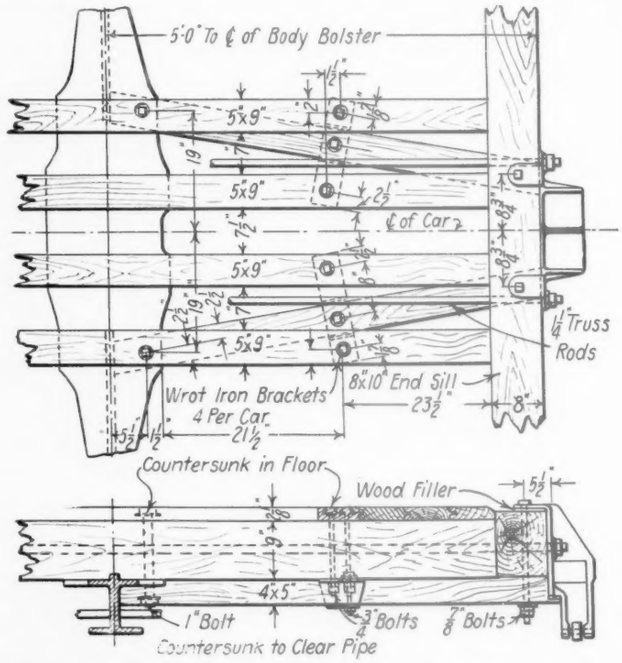


Fig. 2—Method of Bracing Between Striking Plate and Body Bolster

diagonal braces of 3-in. by ⅜-in. material, at the corners in the roof, which are riveted to ¼-in. gusset plates at the side plate and ⅜-in. gusset plates at the end plate. Another road favors the use of lateral straps, three at each end of the car, made from 4-in. scrap boiler flues, all of which can be applied at a cost not to exceed $10 to $12 per car.

Generally speaking, a large number of roads are endeavoring to render additional support to the end plate and centre end posts.

In grain loading, some roads find it necessary to apply metal bands to the outside of the sheathing, in the form of flattened tubes, bar iron or light channel sections. The cost of such applications would probably not exceed $4 per car. A typical design of grain tight end sill arrangement is that in Fig. 3. It is used on steel underframe cars by one large road.

REBUILDING COAL CARS

The question of equipping all-steel coal cars, especially those of the flat bottom type, for extended service after the floor plates and the lower part of the side sheets have become corroded to the extent of impairing the strength of the car and causing the lading to be lost through openings in the frame, is a big problem and its solution depends entirely upon the probable life of the car. In the case of some roads, which operate under unfavorable climatic conditions and handle low grade bituminous coal, re-building is necessary at the expiration of from nine to eleven years, but where service

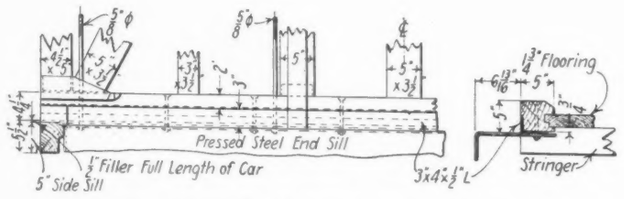


Fig. 3—Grain Tight End Sill for Steel Underframe Cars

conditions are not so severe, the period may be postponed to the fifteenth or even eighteenth year. One road is following the practice of splicing the base of the side sheet as shown in Fig. 4, thus saving eighty per cent of the old material. In the arrangement shown the splice is required to transmit 6,200 lb. when 80,000 lb. is carried by one side. From a material standpoint, a good system to follow would be to have the center sill cover plates 21 in. by ¼ in., and the side sheet splices formed from the same size material and flanged.

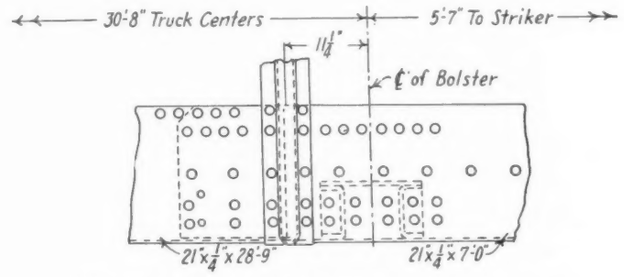


Fig. 4—Detail of Splice for Sides of Steel Coal Cars

In order to keep the sides from bulging, four braces, one located at each cross-bearer and riveted directly to them, were applied. The following is the method of figuring the strength of the splices (See Fig. 4):

Assume 80,000 lb. carried by one side,
Then the vertical shear at the bolster will be

$$S = \frac{80{,}000}{40.66} + 35.66 - 40{,}000 = 30{,}000 \text{ lb.}$$

Where 40.66 = length of car
35.66 = distance from bolster to further end sill.

Therefore the bending moment at the bolster is

$$M = \frac{6\,W\,N^2}{L} = \frac{6 \times 80{,}000 \times 25}{40.6} = 296{,}000 \text{ in. lb.}$$

Where W = the load on the side
N = distance between bolster and end of car.

The tension and compression (P) in the top chord and bottom side sheet due to bending moment M is

$$P = \frac{M}{48} = \frac{296{,}000}{48} = 6{,}200 \text{ lb.}$$

Where 48 = depth of side sheet in in.

Therefore the splice must transmit 6,200 lb.

By using the same material for both the side sill splices and the cover plate splices it can be purchased cheaper and better deliveries will be obtained as the 30-ft. lengths are usually carried in stock. The following is the bill of material for one car:

Two 21 in. by ¼ in. by 28 ft.—9 in. side sheets (body).
Four 21 in. by ¼ in. by 7 ft. side sheets (ends).
One 21 in. by ¼ in. by 29 ft.—5 in. center sill cover plate.
Two 21 in. by ¼ in. by 7 ft.—3¾ in. center sill cover plates (ends).

The efficiency of the centre sill cover plate splice is figured as follows (see Fig. 5):

Gross area of plate (A) 5 sq. in.
Section modulus of the plate is

$$S = \frac{1}{6} \times 20 \times \left(\frac{1}{4} \right)^2 = .21$$

Eccentricity (e) due to offset = ½ in.

Ratio (R) of strength of plate at offset to the strength of the straight plate is:

$$R = \frac{\frac{1}{A}}{\frac{1}{A} + \frac{E}{S}} = \frac{0.2}{0.67} = 0.29$$

That is, the offset reduces the strength of the plate to 29 per cent of the strength of the straight plate.

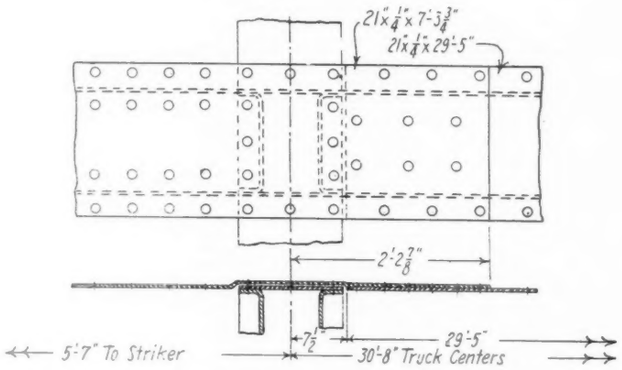


Fig. 5—Splice for Center Sill Cover Plate

The efficiency (E) of the splice is equal to the strength of the riveted joint divided by the strength of the plate.

$$E = \frac{\frac{1}{A \times f \times .29}}{\frac{1}{12 \times V}} = \frac{12 \times 3{,}000}{5 \times 16{,}000 \times .29} = 155\%$$

Where V = 3,000 lb. (shear value of rivets)
f = 16,000 lb. (fibre stress of plate)

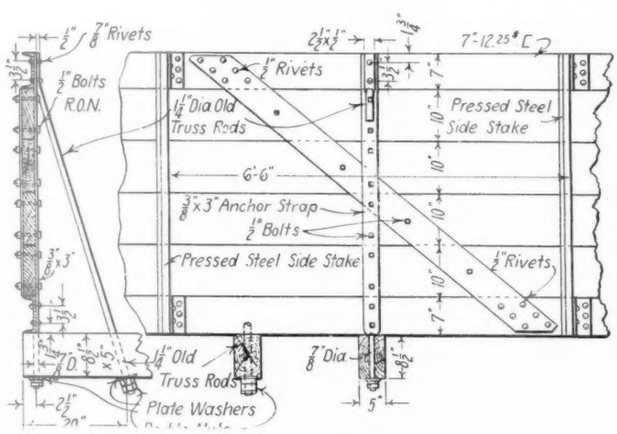


Fig. 6—Side Reinforcement for Steel Frame Coal Cars

That is, the riveted joint is 1½ times as strong as the offset plate.

In connection with reinforcing the ends of steel coal cars, especially where they are used in lumber traffic, it is important to provide against bulging. One road has adopted the use of a double row of pressed steel lateral braces with lipped ends engaging the entire surface of the corner post.

Fig. 6 shows the methods used to reinforce the sides of some steel framed coal cars where eight 1¼-in. diameter truss rods were applied to each car and Fig. 7 shows the practice of using 5-in. by 9¾-lb. I-beam (removed from

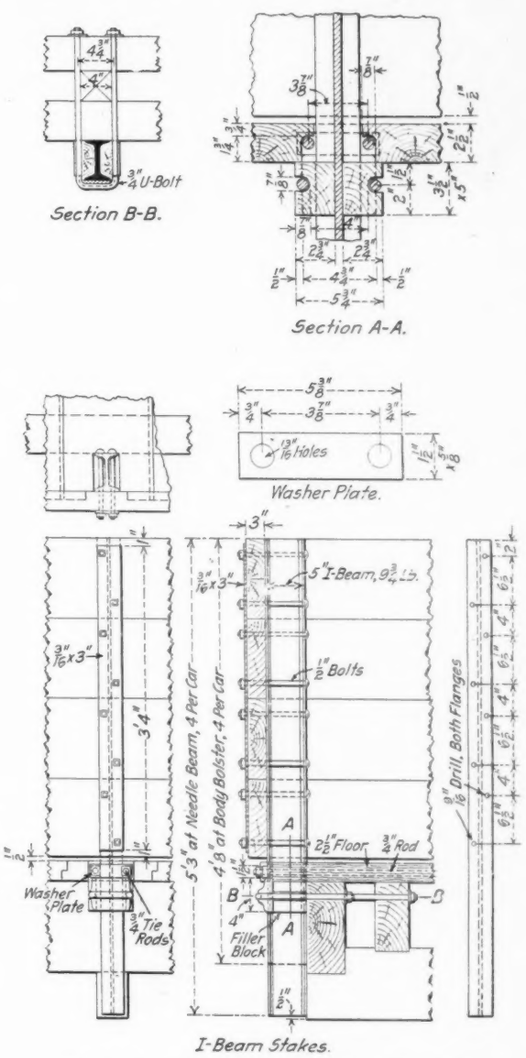


Fig. 7—I-Beam Stakes for Wooden Coal Cars

old brake beams) stakes, eight per car, for 40-ton wooden coal cars and 50-ton steel underframe coal cars.

Fig. 8 shows an economical method of applying planking to the sides of coal cars. The two lower boards are spliced,

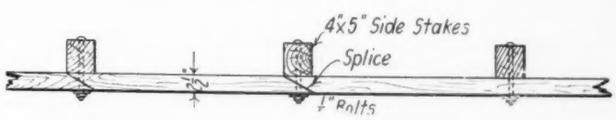


Fig. 8—Spliced Planking for Wooden Sides of Coal Cars

while the upper rows are in one continuous length. No two boards are spliced at the same stake.

The matter of keeping drop doors in good order, especially on general service cars, is a serious problem; it involves the matter of design, deterioration and abuse in service. It is generally agreed that it is impossible to build a door, economically, strong enough to stand both coal and steel mill service, but nevertheless, these are operating problems and the best that may be accomplished is to build the door, so that it

will respond to the action of the operating mechanism without becoming warped or dented. The door can very easily be reinforced by means of angles. One road has developed a two-piece hinge which is keyed in place and admits of easy removal of the doors for repairs, without resorting to cutting out rivets, as the pins on the hinge generally rust in place.

It is often necessary, when considering the matter of reinforcing wooden equipment which has seen service for a considerable period, to provide not only metal draft sills, but new bolsters and crossties, or it may be that the equipment is of large dimensions and needs to be strengthened at the center. Fig. 9 shows a type of framing applied to more than

It was possible in the case of a 50-ton truck recently considered, to reduce the stresses in the bottom arch at the center of the column bolt from 21,000 lb. per sq. in. to 5,000 lb. per sq. in. (practically 400 per cent), by applying a base casting under the columns. Several large roads have recently adopted this practice. This does not mean that liability of failure would be reduced in this proportion, because the most destructive element, namely, crystallization, has not been avoided by the reduction in working fibre stresses above named. As a matter of information, it would be well to appreciate, in this connection, that wrought iron should be used because it has a fibre structure, as against steel which has

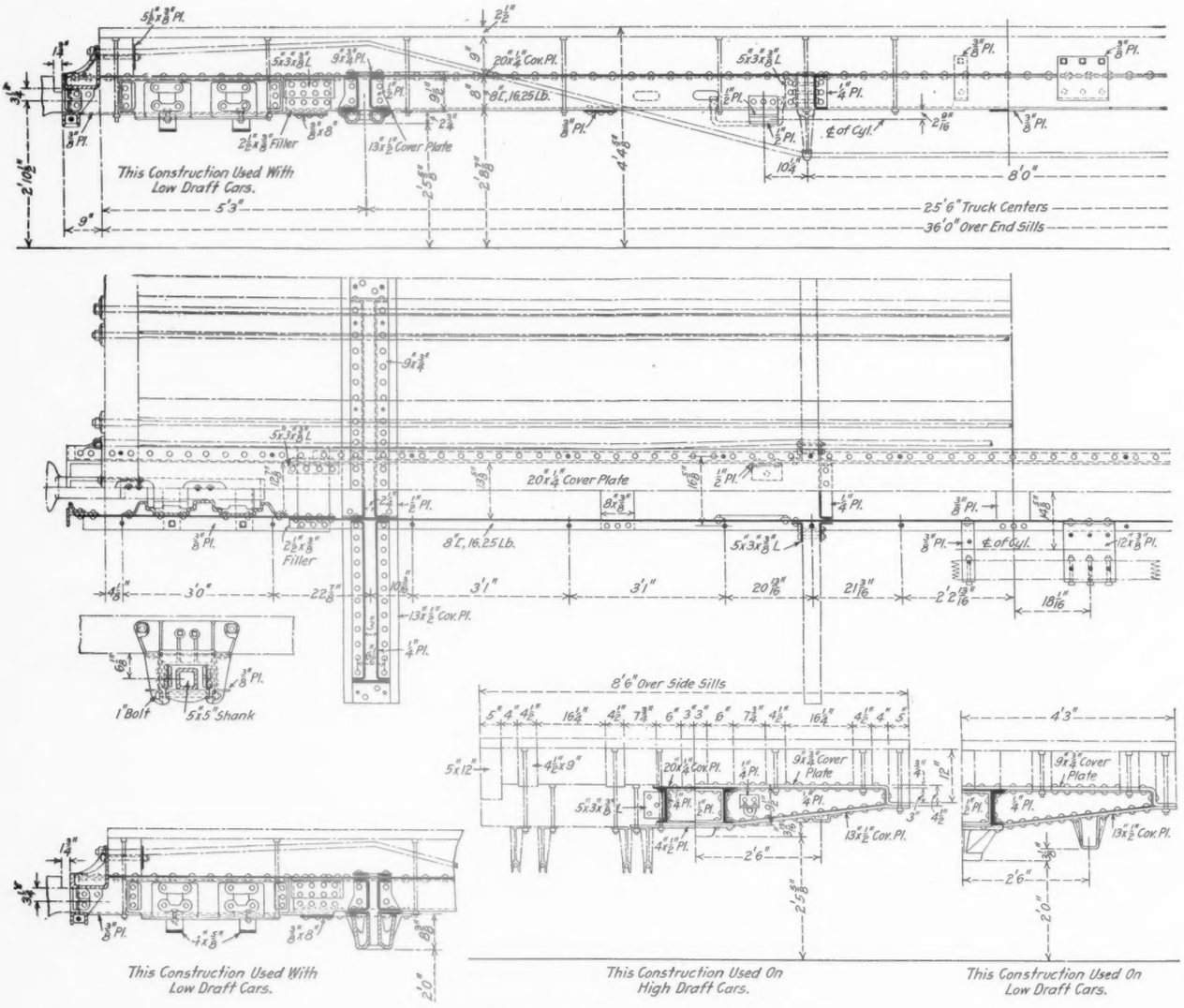


Fig. 9—Reinforced Underframe for 40-ton Coal Cars

3,000 30-foot, 40-ton coal cars operating on a heavy trunk line and is reported as giving excellent satisfaction.

TRUCKS

The question of using a bar section of large breadth for arch bar trucks but having an equal total area presents a problem for discussion. Of two eastern roads operating cars of identical design (they are of the twin hopper all-steel type) the trucks on one road are fitted with 7-in. by 1¼-in. bars whereas on the other road 5-in. by 1¾-in. sections are used. The net area with the wide bar is 6.27 sq. in., while that of the narrow one is only 5.28 sq. in., a difference of 19 per cent with the same gross section.

none, and for this reason, the latter material will crystallize very rapidly under vibration.

Failure of pressed steel trucks is quite common after long service and riveting a U-section reinforcement ½ in. thick over the pedestal can be done economically.

AXLE INSPECTION

The following standard practice covers in plain form a method of presenting the subject of axle inspection to the man on the line. It is the result of very careful calculation and consideration. The great gain in its use appears in the fact that an inspector cannot misjudge the condition of an axle, which often occurs where it is left to his discretion.

No. 1. Standard car axles are provided with 3¼ in. by 7 in., 4¼ in. by 8 in., 5 in. by 9 in., 5½ in. by 10 in. and 6 in. by 11 in. journals when new.

No. 2. Axles must be removed from service if beyond the following limits:

FOR PASSENGER EQUIPMENT CARS

Normal size of journal	Journal dia. not less than	Journal length not more than	Collar thickness not less than	Wheel fit not less than
3¼ in. by 7 in.	3⅛ in.	7¼ in.	⅜ in.	4⅞ in.
4¼ in. by 8 in.	4 in.	8¼ in.	⅜ in.	5½ in.
5 in. by 9 in.	4¾ in.	9¼ in.	½ in.	6¼ in.
5½ in. by 10 in.	5¼ in.	10¼ in.	½ in.	6¾ in.
6 in. by 11 in.	5¾ in.	11¼ in.	5/8 in.	7⅛ in.

FOR FREIGHT EQUIPMENT CARS

Normal size of journal	Journal dia. not less than	Journal length not more than	Collar thickness not less than	Wheel fit not less than
3¼ in. by 7 in.	3⅛ in.	7⅜ in.	¼ in.	4¾ in.
4¼ in. by 8 in.	3⅞ in.	8⅜ in.	¼ in.	5½ in.
5 in. by 9 in.	4⅝ in.	9⅜ in.	5/16 in.	6¼ in.
5½ in. by 10 in.	5⅛ in.	10⅜ in.	⅜ in.	6¾ in.
6 in. by 11 in.	5⅝ in.	11⅜ in.	½ in.	7⅜ in.

No. 3. Journals must be calipered to see if they are worn hollow or tapered. If the difference between the diameters of same journal measured at any two points is 1/32 in. or more, the journal must be turned.

No. 4. Axles must be closely inspected for seams, cracks or flaws. Seamy journals may be returned to service if the seams can be removed by turning, within the required limits. Cracked or flawed axles should be tested by painting the doubtful part with whitewash and then holding a

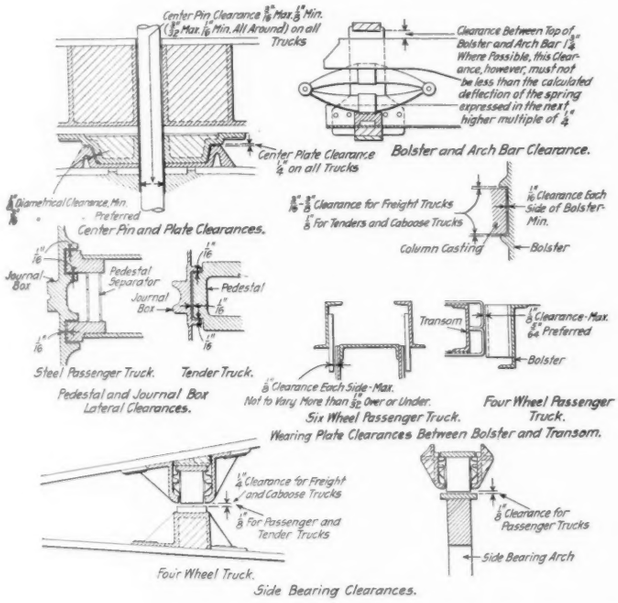

Center Pin Clearance 5/8" Max. 3/8" Min. (1 1/2" Max. 1/8" Min. All Around) on all Trucks
Clearance Between Top of Bolster and Arch Bar 1/8" Where Possible, this Clearance, however, must not be less than the calculated deflection of the spring expressed in the next higher multiple of 1/4"
Center Plate Clearance 1/4" on all Trucks
Bolster and Arch Bar Clearance.
Diametrical Clearance, Min. 1/8" Preferred
Center Pin and Plate Clearances.
3/4"-5/8" Clearance for Freight Trucks
1/2" For Tenders and Caboose Trucks
1/16" Clearance Each Side of Bolster-Min.
Column Casting
Bolster
Journal Box
Pedestal Separator
Pedestal
Journal Box
1/16"
Steel Passenger Truck.
Tender Truck.
Pedestal and Journal Box Lateral Clearances.
Transom
1/16" Clearance-Max. 3/64" Preferred
Bolster
1/8" Clearance Each Side-Max. Not to Vary More than 1/32" Over or Under.
Six Wheel Passenger Truck.
Four Wheel Passenger Truck.
Wearing Plate Clearances Between Bolster and Transom.
1/4" Clearance for Freight and Caboose Trucks
1/8" For Passenger and Tender Trucks
Four Wheel Truck.
1/8" Clearance for Passenger Trucks
Side Bearing Arch
Side Bearing Clearances.

Fig. 10—Inspectors' Chart for Standard Truck Clearance Dimensions

flattener on one end of the journal and striking it with a sledge. Oil working through the paint will indicate a flaw. Axles cracked, flawed or showing signs of excessive overheating or below limits in any respect, must be scrapped.

Defective axles likely to be held for inspection must have in addition to the car number and initials stenciled on the axle, the station symbol, the date removed and defect symbol as follows:

SYMBOL	DEFECT
J	Broken between hubs.
K	Bent between wheel hubs.
L	Fillet at back of journal below limit.
M	Journal length beyond limit.
N	Wheel fit below limit.
O	Good for service.
P	Journal diameter below limit.
R	Cut journal.
S	Burnt journal.
T	Tapered journal.
U	Bent journal.
V	Broken journal.
W	Seamy or flawed journal.
Y	Collar below limit.

No. 5. Scrapped axles should have a piece knocked off the collar.

No. 6. Good judgment should be used in yards and at wheel mounting points in condemning axles. Axles in service should not be removed from cars until worn to the limit, when otherwise in good order. Axles with one or more wheels pressed off must not be returned to service unless ⅛ in. or more above the limit of the journal diameter.

No. 7. Wheel seats must not be turned down except by the smallest amount necessary to true them up, if they require it. Axles must not be turned to fit wheels except when new axles are fitted to new wheels bored to standard dimensions.

No. 8. Fillets on journals must be carefully tried, using a standard fillet gage, placing the gage on the journal parallel with the center line of the axle. If the vertical edge of the gage touches the vertical part of the inside of the shoulder, the axle must be scrapped. Use the corner of the gage with the ⅛-in. radius for axles having 3¼ in. by 7 in. journals and the corner with the ¼-in. radius for axles having 4¼ in. by 8 in., 5 in. by 9 in., 5½ in. by 10 in. and 6 in. by 11 in. journals.

No. 9. M. C. B. limits must be closely followed in condemning axles under foreign cars in service.

The required clearances for the design of new equipment can be made in the form of a standard practice card and a card of this kind is issued to the new equipment inspectors on one of the largest railroads. Fig. 10 shows an inspector's standard practice card for truck clearances that has been found very serviceable.

THE I. C. C. DIVISION OF SAFETY REPORT

The following is taken from that part of the report of W. H. Belnap, chief of the division of safety, to the Interstate Commerce Commission for the year ending June 30, 1916, which refers to safety appliances:

In order to permit of ready comparison with previous years of the results of inspections of freight and passenger cars and locomotives, some of the principal figures for the fiscal years ended June 30, 1914, 1915 and 1916, are shown in the following tabulation:

	1914	1915	1916
Freight cars inspected	790,822	1,000,210	908,566
Per cent defective	5.79	4.77	3.72
Passenger cars inspected	26,746	33,427	27,220
Per cent defective	1.04	2.85	1.82
Locomotives inspected	32,761	38,784	31,721
Per cent defective	4.98	4.06	3.66
Number of defects per 1,000 inspected	67.48	57.23	45.56

A notable feature of the present report is the marked decrease shown in the percentage of equipment inspected during the year which was found defective, the percentage of defective freight cars having decreased from last year's record of 4.77 to 3.72 per cent; the percentage of defective passenger-train cars decreased to 1.82 and of locomotives to 3.66, the percentages for the previous year being 2.85 and 4.06, respectively. This decrease is particularly gratifying in view of the tremendously increased volume of business the railroads have been called upon to handle during the past year, as well as the fact that in addition to maintaining appliances in operative condition carriers were confronted with the necessity of bringing their equipment by July 1, 1916, into conformity with the standards prescribed by the Commission.

A hearing of the carriers before the Commission on September 28, 1915, developed the fact that over a third of a million freight cars would still be unequipped with standard safety appliances on July 1, 1916, and the Commission, on November 2, 1915, granted a further extension of one year within which the carriers shall comply with paragraphs *b*, *c*, *e*, and *f* of its order of March 13, 1911.

Some difficulty is even now expected to be encountered in equipping the cars in service in accordance with the safety appliance standards prescribed by the Commission before July 1, 1917, the date of the expiration of the time granted for completing this equipment, and in order to expedite the equipment of cars according to the standards the Master Car Builders' Association has adopted as a rule of interchange that after January 1, 1917, no car shall be received from its owner unless properly equipped, and that after April 1, 1917, no foreign cars shall be accepted in interchange unless so equipped. The association is to be commended for this action, as it is probable that only through such a course, together with a system of payment for repairs and alterations, can the standardization of this equipment be accomplished by July 1, 1917.

It has been noted that certain carriers vary the size of their car-repair forces with fluctuations of their business, apparently overlooking the fact that the repairs of the kind required by the safety appliance laws can best and cheapest be made at times when their business is not so heavy. The

shortsightedness of a policy that permits material reduction in the force of repairmen and keeps cars standing on sidings unequipped with safety appliances when business suffers some decrease, and requires the employment of a large force of inexperienced men to equip the cars hurriedly when they are needed to take care of increased volume of business, is apparent. The officials in charge of this branch of the carriers' activities should demand that, in order to keep equipment in proper condition, an adequate force of repairmen be maintained at all times. The employment of experienced repairmen is essential to the proper maintenance of safety appliance equipment, and a system of building up a regular force of trained men who are familiar with all the requirements of the law should be more generally adopted.

Number of Defects Per 1,000 Cars or Locomotives Inspected During the Year Ending June 30, 1916.

Couplers and parts	6.09
Uncoupling mechanism	4.17
Visible parts of air brakes	20.58
Handholds	5.00
Heights of couplers	1.08
Steps	.62
Ladders	.77
Running boards	2.20
Hand brakes	4.55
Safety railings	0.05
Footboards	.28
Pilot-beam sill steps	.06
Handrails	.08
Steps for headlights	.02
Power brakes	.01
Ash pans	.02
All classes	45.56

During the past year an increase of 1.29 per 1,000 cars inspected is noted in the number of defects to couplers and parts, and the Commission's Accident Bulletin No. 60, for the year ended June 30, 1916, records the death of 123 employees and the injury of 2,194 employees while coupling and uncoupling cars. With the great variety of couplers now in use it not uncommonly happens that proper parts for making repairs are not available, and frequently defective parts of couplers are replaced with wrong castings, the result being that in many cases the couplers fail to operate in the manner intended. After several years of work the coupler committee of the Master Car Builders' Association has recommended the type D coupler, and this type of coupler has been adopted as standard by that association. An increase of 33 per cent in weight of this coupler, as compared with those now in use, is compensated for by an increase of 100 per cent in strength and 300 per cent in estimated minimum life.

It is not to be expected that defects will not develop in service which will need to be corrected. But the adoption of a standard coupler is an epoch-making step. As soon as this standard is brought into general use the carriers will be relieved of the enormous expense incident to supplying repair parts for the great number of different couplers now in use, and a much safer operating condition will be brought about by the use of one form of coupler with which every employee will be familiar. Yet the mere fact that its adoption has received a favorable vote may mean little unless those who have voted for it exert every effort to see that the coupler is actually put into use. Much time and money have been spent in developing the coupler and to demonstrate its advantages over others now in use. The obvious advantages of standardization of coupler equipment should lead to its immediate introduction and use.

With the more general adoption of uncoupling devices having rigid connection between uncoupling lever and lock block there has been a slight decline in the number of cars per thousand inspected with defective uncoupling mechanisms, this number having decreased from 5.10 to 4.17 during the past year.

Cases continue to be reported where cars are equipped with handholds less than 16 in. in clear length. The order permits the use of 14-in. handholds only where it is impossible to apply those 16 in. in length. The extension of the handhold beyond the face of the car in order to provide the minimum clear length required is a practice that should be discontinued and cars on which handholds are so applied will be reported as defective by our inspectors.

A great many handholds, ladder treads and sill steps are being reported loose, the nuts on the bolts securing them to the cars not being properly riveted over.

A marked decrease is noted in the number of defects to air-brake equipment reported, which is indicative of the growing tendency toward 100 per cent efficiency of power brakes in trains. This result can not, however, be attained so long as only enough brakes are kept in operative condition to allow trains to go forward with the minimum of 85 per cent of the air brakes required by Law in operative condition. Much has already been said about the imperative need of greater care in the maintenance of air brakes, and much good has been accomplished, but there is still a great deal to be done before that efficiency of air brakes which is contemplated by the law is secured.

Proper maintenance of air brakes can only be had by the employment of competent men. In this connection it is encouraging to note that the carriers are educating their inspectors in the more efficient discharge of their duties and are securing men who have a better knowledge of air-brake systems. And in many instances, also, yards have been equipped with compressors and air lines for testing air-brake equipment and enabling proper repairs to be made.

It is clearly manifest that the intention of the Commission, as set forth in its order of June 6, 1910, was that all power-braked cars in trains should have their brakes used and operated from the locomotive drawing the train, and several suits have been instituted in order that this part of the law may be tested in the courts and its true intent defined.

A recent decision of the District Court of the United States for the Eastern District of Washington is of great importance, as it gives a comprehensive construction to the power-brake provision that the train shall be so equipped as to run without requiring the use of the hand brakes; it is held that this is a prohibition against the use of the hand brakes in the ordinary movement of trains, and the language of the act was equivalent to declaring that after the date named freight trains should not only be equipped to run, but should actually be run without requiring brakemen to use the hand brake.

The Circuit Court of Appeals, Third Circuit, has decided that the requirement of efficient air-brake equipment presupposes that such equipment shall be inspected at terminals.

The importance of terminal tests as an element of safety in railroad operation can not be overestimated. At many terminals the only air-brake test made consists merely in ascertaining whether or not the air is working throughout the train line. Such a test provides no adequate information as to the efficiency of individual brakes, and, as inspection has shown, trains are not infrequently permitted to leave terminals with insufficient braking power. In this connection a system of careful inspection and tests at terminals is strongly urged.

An important adjunct to the air-brake system that receives but slight, if any, attention by roads operating in level country, is the retaining valve. Since there is little or no need for them on these lines, the roads contend that they should not be expected to maintain them. The result is that on roads having heavy grades the work of repairing and maintaining retaining valves, as well as applying them when these devices are missing from the cars offered in interchange is unduly burdensome.

As was stated in last year's report, an air-brake gage in the caboose, together with a conductor's valve that is readily available in case of emergency, is important for the proper handling of long trains. Without this gage to indicate the

brake-pipe pressure the trainmen on the rear of the train are in ignorance of the air pressure available for use and have no means of knowing with certainty whether their trains have sufficient air in reserve properly to control them.

In addition to the increased attention being given the power brakes on cars, a decrease in the percentage of defective hand brakes is shown. This is due to the general improvement of safety appliance conditions occasioned by the better understanding of the standards than to any especially important event drawing attention to the necessity for hand-brake maintenance. Notwithstanding the increased efficiency of the air brake no less consideration should be given the hand brake, as it is just as necessary in controlling the speed of cars being set on sidings and while making up trains as the air brake is in controlling the speed of the train when made up. A hand-brake decision of importance defines the word "efficient," as used in the statute, as comprehending the efficiency of the hand brake for the purpose of holding a car or train, as well as its efficiency as a matter of safety to employees engaged in work requiring the use of hand brakes.

An important decision recently rendered by the District Court of the United States, Northern District of California, fixes the liability for the penalty provided by the safety appliance acts for their violation upon the common carriers "permitting" the use on their lines of equipment not in conformity with the requirements in such cases.

Much expense could be spared the carriers if some method of instruction in the proper manner of loading logs and lumber on flat cars were adopted, so as to prevent the loads from shifting and coming in contact with the brake shaft or wheel, causing the hand brake to become inoperative. The 4-in. clearance around the rim of brake wheel should be maintained as well between the rim of the wheel and the lading as between the rim of the wheel and parts of the car itself if the degree of safety contemplated by the law is to be provided, but cars are frequently loaded in such a manner that the hand brake is entirely obstructed.

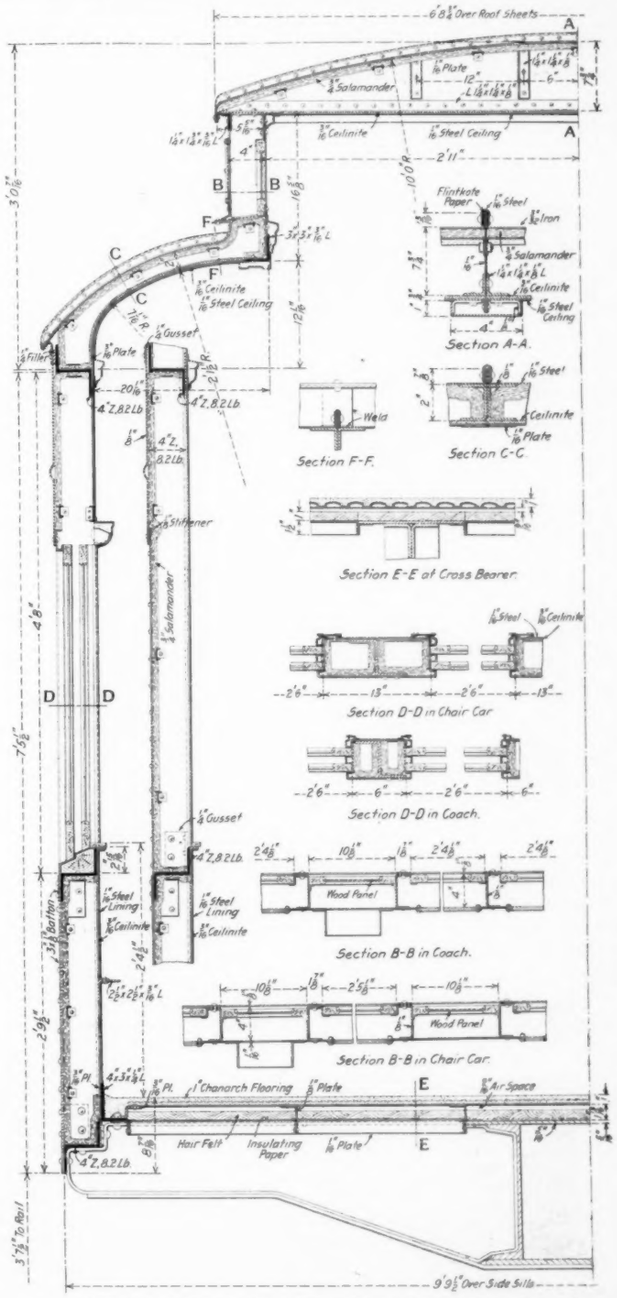
Two decisions recently rendered by the Supreme Court of the United States construe the provisions of the safety appliance acts as applying to electrically operated railways as well as to steam railways, thus establishing that cars operated on such railways shall have the complement of handholds, sill steps, hand brakes, and other safety appliances required by the safety appliance law, and that trains operated over such lines shall have their speed controlled by power brakes.

ALL STEEL PASSENGER CARS FOR THE CHICAGO, BURLINGTON & QUINCY

The Chicago, Burlington & Quincy has recently received from the American Car & Foundry Company fifteen chair cars, fifteen coaches, nine combination baggage and smokers, and two combination coach and smokers, of all-steel construction. The specifications of these cars comply in detail with the government's specifications for steel cars, and in many cases exceed these requirements. The construction adheres very closely to that which was made standard on the Burlington a few years ago and which was described in the *Railway Age Gazette, Mechanical Edition,* of February, 1914, page 77. All of the new cars have vestibules, except the combination baggage and smokers, which have a vestibule on one end only, the other end being of the dummy type. The chair cars weigh 140,000 lb. and have a seating capacity of 64, which gives a dead weight per passenger of 2,190. The chairs are located on 3 ft. 7 in. centers. A space of 5 ft. on each end of these cars is given over to toilet facilities, one compartment containing the closet, the other the wash bowl with hot and cold water, a drinking fountain and mirror. The women's end contains in addition to this two seats with leather covered cushions.

The coaches weigh 141,000 lb. and have a seating capacity of 84, giving a dead weight of 1,680 lb. per passenger. The seats are located on 2 ft. 11½ in. centers. A women's wash room and a closet occupies a space 4 ft. 6¼ in. long on one end of these cars and the men's closet and the wash room occupies a space of 3 ft. 4¼ in. on the other end. The combination coach and baggage cars weigh 137,000 lb. and have a seating capacity of 36. The length of the baggage section is 40 ft. ¼ in. and the coach section is 30 ft. ¼ in. long. This section is provided with a stove, a closet and cooler.

The cars are of the clere story type, the upper deck windows having been omitted, and the only openings are those

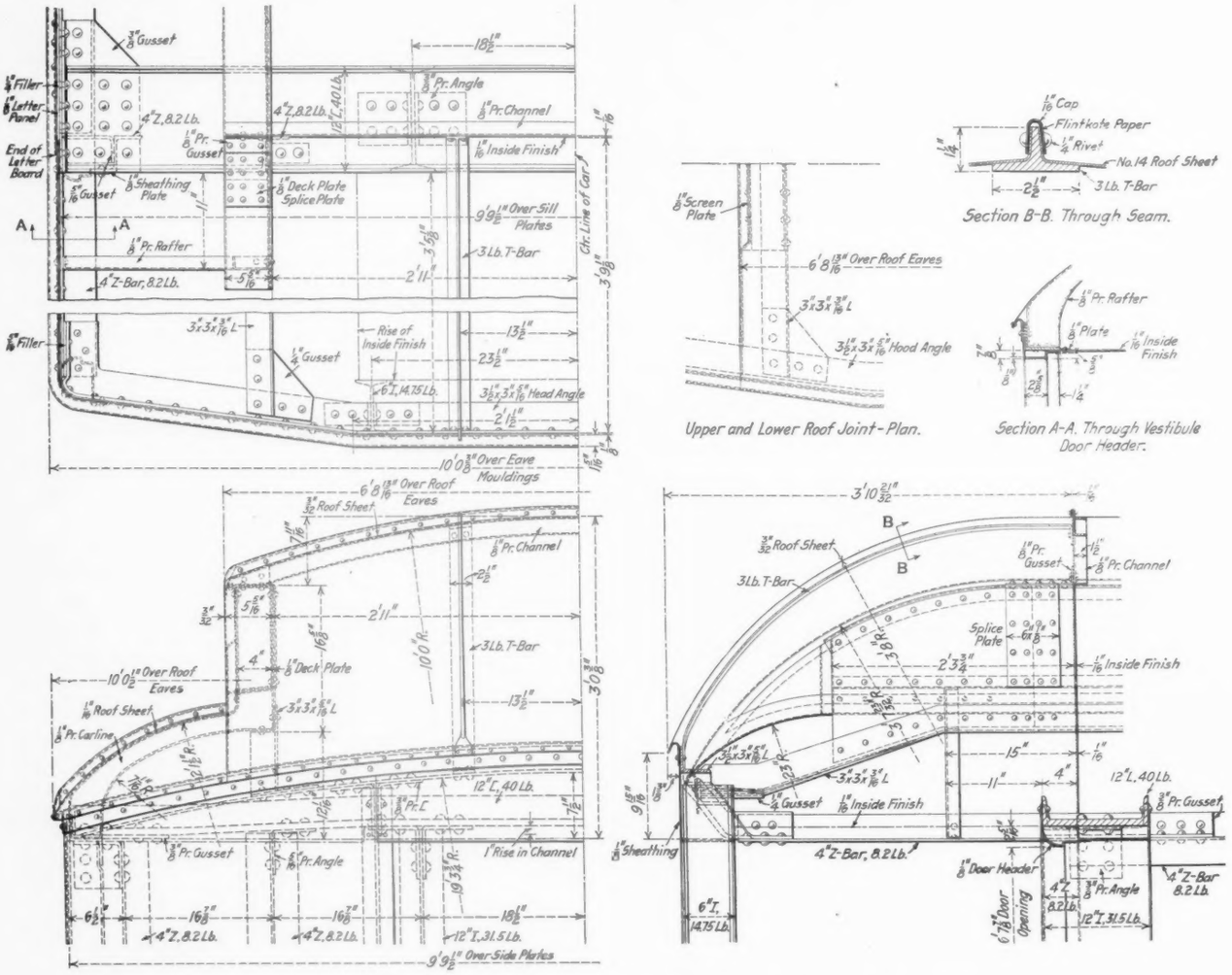


Cross Section of the Burlington Passenger Cars

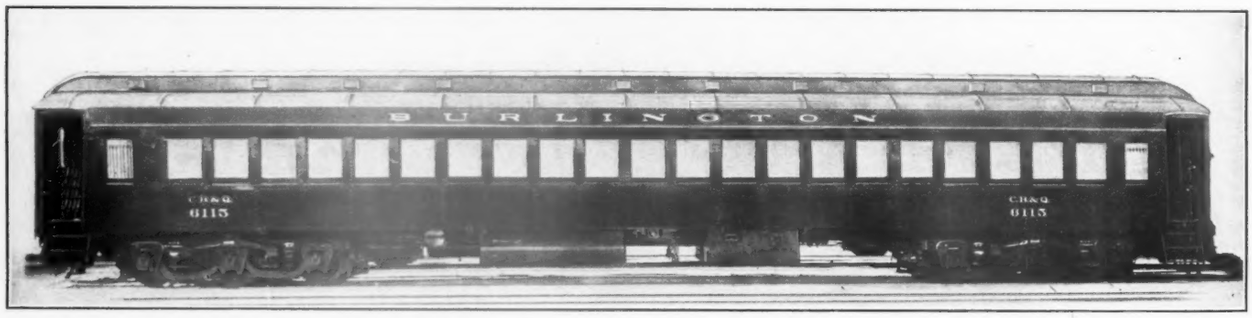
required for the ventilators. The side carrying type of construction is used, the sides being considered as being supported at the double body bolsters. This leaves the center sills to take care of the buffing and pulling strains only. These are designed for a maximum end shock of 400,000 lb. considered as a static load. The center sills are made up of

15-in., 33-lb. channels spaced 16 in. back to back with a 5/16-in. by 28-in. top coverplate extending from end sill to end sill, and a bottom coverplate 5/8 in. by 24 in. extending between the draft castings. The bolsters and cross bearers are of built up construction, having pan shaped web plates with ample connections at the center and side sills. The end sills are made up of pressed steel shapes. The corner, side and intermediate end posts are 4-in., 8.2-lb. Z-bars. The door posts are 12-in., 31.5-lb. I-beams and the vestibule diaphram posts are 6-in., 14.75-lb. I-beams. The end plates on the body of the cars are 12-in., 40-lb. channels and on the vestibule 3½-in. by 3-in. by 5/16-in. angles. The side plates and side sills are 4-in., 8.2-lb. Z-bars.

A cross section of the cars taken through the window is shown in one of the illustrations. It is common to both the chair cars and the coaches, with the exception of sections B-B and D-D. Contrary to previous practices the Gothics and segment sash above the side windows have been omitted, making it possible to increase the height of the window glass 4 in., giving a clear glass opening 29 in. high. A larger amount of natural light is thus admitted to the cars than before. This arrangement has made a greater depth of letter board necessary.



Vestibule Hood Construction—C. B. & Q. Steel Passenger Cars



All-Steel Passenger Cars for the Chicago, Burlington & Quincy

essary, it now being 21⅞ in. deep. In order to improve the appearance of the car and also to stiffen this sheet a groove is pressed in the letter board 8⅛ in. above the bottom. Another interesting feature to be found in the cross section is the manner of riveting the roof sheets. They are so applied that both rivet heads are on the outside of the car where they are readily accessible. This permits the roof sheets to be readily removed whenever desired.

The cars are insulated on the roofs, sides and ends with ¾-in. 3-ply Salamander secured to the inside of the outside sheet, and 3/16-in. Ceilnite applied to the back of the inside sheet. The floor is built up of a 1/16-in. steel sub-floor on which is applied a layer of insulating paper, a 1-in. course of hair felt, a 9/16-in. air space and a No. 18 Toncan metal Chanarch flooring ½ in. in depth which in turn is covered with Magnesite cement. Aisle strips of interlocking rubber tiling are used on the chair cars and coaches. This floor construction has proved to be an excellent insulator of sound.

These cars are lighted by 50 and 15-watt lamps. The coach has 10 of the 50-watt lamps in the middle of the car, as shown in the illustration. The fixtures are of the semi-indirect type, being furnished by the Adams & Westlake Company. In addition to this there are twelve 15-watt lamps located as follows: Two in each vestibule, two in the women's compartment, one in the men's closet compartment, one in the men's washroom and one each side of the partition between the toilet compartment and the car. Five emergency candle fixtures are located on each side of the car, and two in each toilet compartment. The chair cars have eight of the 50-watt semi-indirect units, and twelve 15-watt units located substantially the same as in the coaches, and 12 emergency candle fixtures. The passenger ends of the combination cars are equipped with four 50-watt semi-indirect units, five 15-watt units, and four auxiliary candle fixtures. The baggage end is lighted by four 15-watt fixtures, and has four auxiliary candle fixtures. Three of the coaches are equipped with the axle generator system, the others being equipped with the head end system.

Interior of Burlington All-Steel Coach

Six-wheel trucks of the Commonwealth Steel Company's design are used under all the cars. They are provided with the American Brake Company's clasp brake, and have 36-in. rolled steel wheels. The following is a list of the general dimensions of the cars:

Length over sills	70 ft. 8¼ in.
Length over buffers*	79 ft. 6½ in.
Length inside	70 ft. ½ in.
Width inside of lining	9 ft. 1½ in.
Width over side sills	9 ft. 9½ in.
Width over eaves	10 ft. ½ in.

*For the combination cars this length is 74 ft. 9½ in.

MAINTENANCE OF AIR BRAKES ON FREIGHT CARS*

BY H. S. WALTON

Supervisor of Air Brakes, Boston & Albany

Up to within a few years the importance of maintaining the brakes on freight cars did not seem to be fully realized, and the railroads seemed loath to spend the money to install the apparatus necessary for the proper testing of freight brakes at terminals. Formerly, the only test made was to see the brakes applied and released after the train was made up and the locomotive coupled on—then the train was hurried out of the yard.

Agitation by the air brake supervisors has resulted in many roads installing yard-testing plants, and the excellent results obtained have demonstrated that the investment has been a paying one. There is, however, room for improvement, as many roads are still without these testing plants.

A yard-testing plant is as necessary to the proper maintenance of air brakes as a locomotive is to the hauling of a train. The testing plant should consist of a compressor of sufficient capacity to charge the maximum number of cars in a reasonable time; a cooler for the air to pass through (to obviate condensation in the lines), a storage reservoir with a capacity equal to the volume required to charge the maximum number of cars; piping of such size and alignment as will permit of the unrestricted flow of air, and a portable testing truck or other device for operating the brakes. Air brake inspectors should be selected by the supervisors of air brakes, with a view to obtaining men of sufficient intelligence to become efficient in the performance of their duties; and the position should be made sufficiently attractive to induce men of such capacity to accept it.

TESTING TRAINS

The brake pipe and auxiliary reservoir should be charged to 70 lb. The inspector should then go over the train, cutting in all brakes found cut out, noting the condition of the foundation brakes and stopping all leaks in the hose couplings and pipe joints. The brakes should then be applied with a 20-lb. reduction of the brake pipe pressure. The brakes should again be looked over, and all cars marked, or carded, on which the brakes have not applied or on which the piston travel needs adjustment. The brakes should then be released and looked over to ascertain if all have released. Minor repairs should be made immediately and cars requiring heavy repairs carded for the repair track.

CLEANING TRIPLES

In cleaning a triple valve it should be dismantled, and all internal parts, except those with rubber seats and gaskets, cleaned with gasoline, then blown off with compressed air and wiped dry with a cloth. All worn or defective parts should be repaired or replaced, and special care should be taken to clean out all ports and passages. The seat and face of the slide valve and slide valve graduating valve, also upper portion of bushing where slide valve spring bears, and the triple valve piston and its cylinder should be lubricated with a high-grade lubricant. No lubricant should be applied to the emergency piston, emergency valve or check valve. All triple valves, after being cleaned, should be tested on a rack

*From an address before the January meeting of the New England Railroad Club.

conforming to the M. C. B. standards. In cleaning brake cylinders all deposits of gum and dirt should be removed with a putty knife, and the piston and interior of the cylinder cleaned with waste saturated with kerosene. All rust spots should be removed.

Particular attention should be given to cleaning the leakage groove and auxiliary reservoir tube. Cracked or worn packing leathers should be replaced by new ones. The expanding ring should be removed from the piston, and replaced by a ring of the proper dimension, the old ring to be sent to the shops to be gaged and adjusted to the proper size.

The inside of the cylinder, and both sides of the packing leather should be lightly coated with a suitable lubricant.

The brake cylinder should be tested for leakage after cleaning, preferably with a gage, and leakage should not exceed 5 lb. per minute from an initial pressure of 50 lb. Each time the triple valve and brake cylinder are cleaned, the brake pipe, brake pipe strainer, and branch pipe should be blown out, and the triple valve strainer cleaned before reconnecting the branch pipe to the triple valve. If a dirt collector is used, the plug should be removed and the dirt blown out.

The restricted exhaust port in the retaining valve should be cleaned each time the triple valve is cleaned, and the valve and pipe connecting it to the triple valve should be tested. Special care should be taken to have all pipe clamps tight. It should be seen that there are no worn, defective or missing parts of the foundation brake, and in replacing such parts care should be taken to have them of the proper dimensions.

Thus far we have made a simple statement of what we believe to be necessary to maintain the brake, but this paper would be incomplete without a statement as to some of the penalties for neglect.

PENALTIES FOR NEGLECT

Brake Pipe Leakage.—This is a menace to the safe and successful handling of trains, because it is almost impossible for an engineer, be he ever so skillful, to do proper and safe braking, especially in descending grades. If he makes sufficient reduction to insure the application of the brakes, with a view to regulating the speed of the train, it is possible that he will, in order to avoid stopping, have to release the brakes at a time when such a course would be inadvisable and possibly dangerous, for it may be at a point where signals, though not far distant, are not visible. Then again, brake pipe leakage is conducive to stuck brakes, flat wheels, and undue quick action, which often results in damage to draft gear and lading.

Furthermore, brake pipe leakage is very expensive when we consider the wear and tear of the pump and the additional consumption of fuel. Let us consider the latter in connection with a 70-car train assumed to have one-half 8-in. and one-half 10-in. equipment. A leakage of 5 lb. per minute on this train, with a 70-lb. train pipe pressure would amount to 39.5 cu. ft. of free air per minute, or 23,700 cu. ft. of free air in ten hours. The 8½-in. cross compound pump, driven with 200-lb. steam pressure would require three hours and five minutes to compress the air lost, and in doing that amount of work 5,782 lb. of water would be evaporated; and assuming that 8.5 lb. of water is evaporated with one pound of coal 680 lb. of coal would be consumed.

The New York No. 5 pump would require three hours and twenty minutes to do the same amount of work and would use 10,475 lb. of water and 1,230 lb. of coal. For the 9½-in. pump this work would require nine hours and eleven minutes with 15,144 lb. of water and 1,780 lb. of coal.

Triple Valve.—Many cases of slid flat wheels may be traced to a worn triple valve piston packing ring or bushing, and undue quick action is invariably the result of a broken carrying pin, weak graduating spring or obstructed service graduating ports.

Brake Cylinder.—The result of brake cylinder leakage is the reduction or entire loss of braking power on the car and it necessarily follows that it will require a greater distance in which to stop the train as the work will have to be performed by the brakes of the other cars. Brake cylinder leakage also contributes to shocks, as the cars with effective brakes will be retarded more quickly than those with ineffective brakes.

Piston Travel.—Variation of piston travel makes a difference in brake cylinder pressure which often causes an unequal distribution of braking power in a train. For example, with a 10-lb. reduction of the brake pipe pressure a 6-in. travel gives 33 lb. brake cylinder pressure; an 8-in. travel 23 lb., and a 10-in. travel 16 lb.

On a railroad within a thousand miles of Boston there were 1,161 drawbar failures during the year ending June 30, 1916, and while there is no available data to show what per cent of these failures could be properly charged to defective brakes, the number would have been much less had there been a greater uniformity of piston travel and less brake cylinder leakage.

Foundation Rigging.—The average repair man pays scant attention to the foundation brake rigging, for if he finds the required number of rods and levers he does not concern himself as to their condition. In case of a broken or missing lever he, in the absence of a duplicate, often uses any lever that may be in stock, and should these levers be of wrong dimensions it will increase or decrease the braking power to such an extent that it may lead to serious consequences, such as slid flat wheels, shocks, etc.

Pressure Retaining Valves.—The pressure-retaining valve is not a necessity on level roads, but becomes an important feature on roads having heavy grades. These valves, when in operation, retard the flow of air from the brake cylinder in releasing the brakes to such an extent that the escape of pressure down to the closing of the valve is about six or seven times as long as it would be if the retainer were not in use. Furthermore, a certain amount of pressure is retained in the brake cylinder, and on subsequent applications of the brakes, the brake cylinder pressure builds up from the retained pressure instead of from atmospheric pressure, with the result that we can, by using these valves, control a train down a grade with about one-fourth to one-third the volume of air that would be required without their use. The proper maintenance of the pressure retaining valves will not only enable us to control our train more safely on descending a grade, but will effect a considerable saving in fuel.

THE CONDUCTOR'S RELATION TO THE OILER*

BY M. GLENN, Sr.
Ludlow, Ky.

A train of freight cars leaves a terminal with the oil boxes well oiled and packed, and the brasses all O. K. The train is in charge of the conductor, who should make a report of the hot boxes on his train on arrival at the terminal. The oiler, who must be an expert, must examine the hot boxes reported to him, and make a report of his examination and work on them and forward it with the conductor's report attached, to his foreman. This will prevent a great number of cars with hot boxes from being switched on side tracks for unloading and then getting back into service when empty.

The oiler will also recognize the hot boxes on the arrival of trains at terminals much more easily than he will defective boxes on trains leaving the terminals.

*This article was entered in the Hot Box competition which closed October 1, 1916.

EXPANSION OF ZINC.—Of all common metals zinc expands and contracts the most for any increase or decrease of temperature; hence it is sometimes particularly valuable where expansion and contraction with variations of temperature are desirable.—*Railway and Locomotive Engineering.*

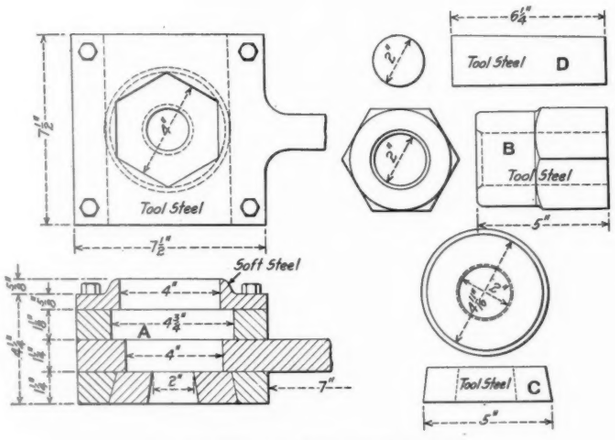
Shop Practice

FORMING KNUCKLE PIN NUTS UNDER THE STEAM HAMMER

BY H. C. GILLESPIE

The tool shown in the drawing is a die designed for punching knuckle pin nuts out of flat bars, which is in use in the Peru, Ind., shops of the C. & O. It is used in connection with a steam hammer. The material for the nuts is either bought of the proper thickness, and slightly wider than the nuts, or it is forged in the blacksmith shop.

The bars are heated in an oil furnace and are then inserted



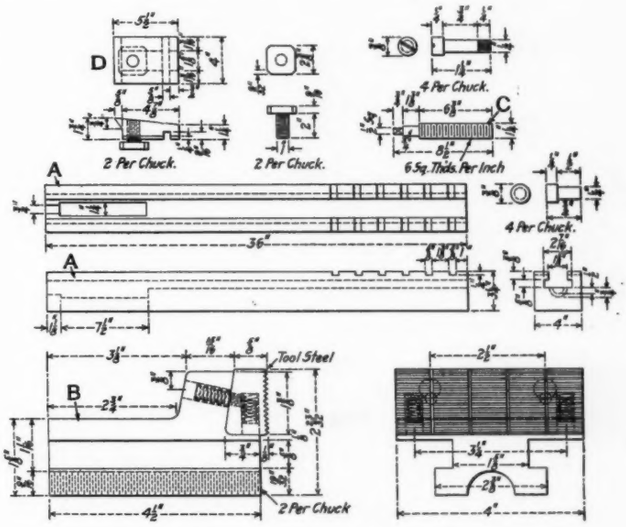
Die for Forming Knuckle Pin Nuts

in the slot *A*. The hexagon punch *B* is placed in the die and struck with the steam hammer. This forces the blank down against the die *C*. The round punch *D* is then placed in the hole in the hexagon punch *B*, and struck with the hammer. This completes the forging, which is finished on a drill press equipped with a tapping attachment. By the use of this die it is possible to turn out knuckle pin nuts at the rate of one a minute.

MACHINING SHOES AND WEDGES

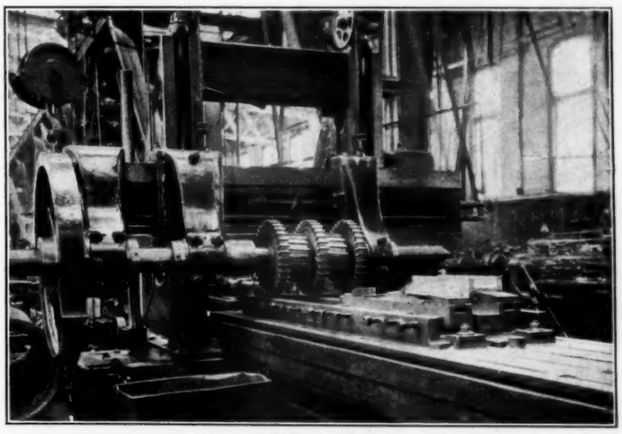
By the use of a slab milling machine and the Morton draw cut shaper shoes and wedges are machined ready for application, in 13½ minutes at the Dale street shops, St. Paul, of the Great Northern. The illustrations show the methods followed for preparing the shoes and wedges on the slab milling machine. The photograph shows a shoe set up ready for milling, and the drawing gives the details of the chuck which holds the shoe. On the milling machine all surfaces, except the face, are machined with one cut. The shoes and wedges are then placed in stock to be used as required. The milling machine work takes 6½ minutes per shoe or wedge, and the shaper operation takes 7 minutes. As the shoes are required they are taken to the engine and "pop" marked for finishing.

The chuck on the milling machine consists of the base *A*, which is clamped in a frame, as shown in the photograph. This base is provided with a T-slot, in which slides the binding jaw *B*. It is controlled by a square threaded lead screw *C*, which meshes with *B* on its upper half and with *A* on the lower half. The jaw *B* is made of cast iron and is



Chuck for Milling Shoes and Wedges

provided with a tool-steel face which fits into the jaw on an angle, and which is held in position by springs, as indicated in the drawing. This construction insures a pulling down grip as the binding jaw is forced onto the work, thus keeping it firmly on the bed of the chuck. The back rest is



Method of Machining Shoes and Wedges on a Slab Milling Machine

shown at *D*. It is provided with a T-bolt which slides in the T-slot of the base and it is held in position by means of a key which fits in a keyway in the back rest and in the chuck base. Several keyways are provided in the base *A* to accommodate the various lengths of shoes. With the arrangement

shown several shoes or wedges can be milled at the same time. The shoes are allowed to lay flat on the chucks while the wedges are raised at one end to give the proper taper.

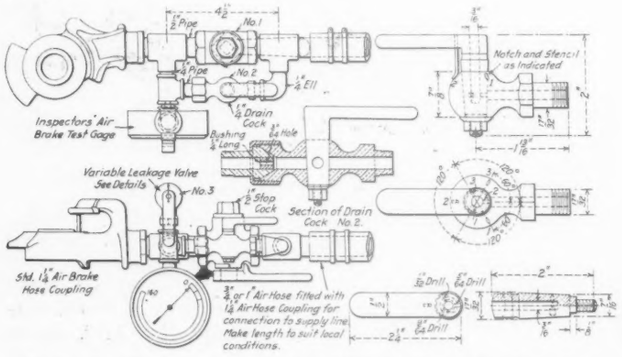
APPLIANCES FOR TESTING FREIGHT CAR BRAKES IN YARDS

BY M. K.

To furnish a simple means of testing triple valves without removing them from the car, the apparatus shown below has been developed. It is designed for use on freight cars and has proved to be a great convenience in yards. The principal parts of the device are a 3½-in. inspector's test gage, a ½-in. cut out cock and two special cocks, the construction of which will be described in detail. The device as assembled is arranged to be connected to the air hose on the car and the 1-in. air hose leading to the compressed air line.

The variable leakage valve, No. 3, is shown in detail in the drawing. It is arranged to discharge air through three orifices of different sizes, the center of the plug being drilled out with a 3/16-in. drill and having three holes of 9/64-in., 5/64-in. and 1/32-in. diameter, respectively, through the walls of the plug. The positions of the plug when each of the orifices is open is indicated by a pointer and numbers on the body of the valve. In the normal position of the valve, the handle is along the body and the orifices are closed.

The valve, No. 2, which forms a by-pass around the stop cock, No. 1, is a standard ¼-in. drain cock which has a bushing with a 3/64-in. hole in the union tailpiece. The device is coupled to the hose on the car and to the compressed


Inspectors' Air Brake Test Gage
Variable Leakage Valve See Details
No. 3
No. 1
No. 2
Notch and Stencil as Indicated
Section of Drain Cock No. 2.
Std. 1¼" Air Brake Hose Coupling
Make length to suit local conditions.

Device for Testing Triple Valves Without Removing from Cars

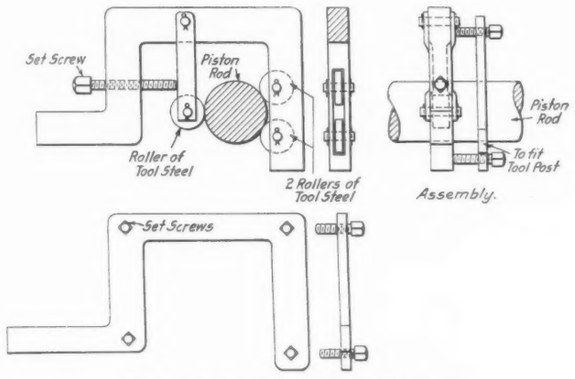
air line, a dummy coupling being placed on the hose on the opposite end of the car. Then the cock No. 1 is opened and Nos. 2 and 3 are closed, the hose and all pipes being examined for leaks. After all leaks have been stopped, the cock No. 1 is closed and the variable leakage valve is placed in Position No. 1 (9/64-in. opening). At this rate of reduction of brake pipe pressure the brake must apply in quick action. The variable leakage valve, No. 3, is then closed and cock No. 1 opened until both the brake pipe and the auxiliary reservoir are charged to 70 lb., then the cock No. 1 is closed and the variable leakage valve placed in position No. 2. If the triple valve applies in quick action in this position, it must be removed, cleaned and tested on the test rack.

Valve No. 3 is then closed and stop cock No. 1 opened until the brake pipe and auxiliary reservoirs are again charged to 70 lb. The retaining valve handle is turned up and cock No. 1 closed and the variable leakage valve placed in position No. 3 until the brake pipe pressure has been reduced 15 lb. If the brakes fail to apply, examination must be made to determine the cause. If the brakes apply, cock No. 1 is opened and if the brakes then fail to release, the triple valve must be removed and proper repairs made.

ROLLER TOOL FOR FINISHING PISTON RODS

BY A. J. HUMPHREY

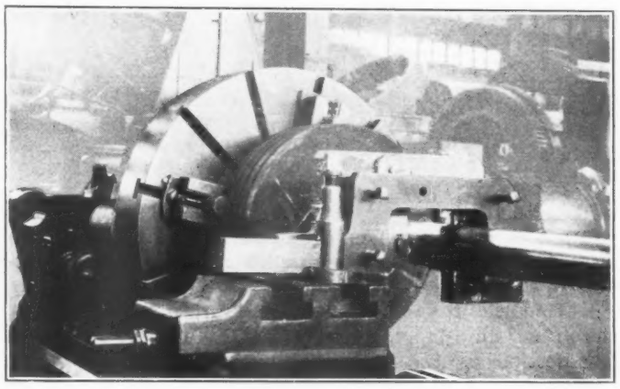
A roller tool for finishing piston rods which does not have the objectionable features of the usual type with but one roller is shown below. In order that the rod may be rolled close up to the piston head, the tool is made in two sections. One section carries the rollers, of which there are three, two behind the rod and one in front of it. The roller



Details of the Piston Rod Roller Tool

in front of the rod is on an arm which is free to swing, and pressure is applied to this roller by a set screw bearing against the arm. The construction of this feature resembles that of a hand-operated pipe cutter.

The other section is clamped in the tool post and feeds the roller section by means of set screws pressing against it.



The Roller Tool in Operation

By adjusting these set screws, the rollers can be set so that they will not roll ridges on the rod. With this tool there is no tendency to spring the rod, even though considerable pressure is used and the work may be run at a high rate of speed without heating the dead center.

MACHINE TOOL EXPORTS.—The machine tool exports from America during the year ending June 30, 1916, are said to have exceeded $61,000,000, of which about $48,000,000 left through the port of New York. This is more than twice the amount of similar exports for the previous year.

LOOK BEFORE YOU JUMP.—Upon taking charge of a new plant, do not begin by making promiscuous adjustments. It is better to wait a day or two until the apparatus is thoroughly understood, and then changes should be made only after the object to be attained is definitely known.—*Power.*

APPLYING LOCOMOTIVE BOILER TUBES*

Outline of Shop Methods for Handling and Renewing Boiler Tubes and Welding Them in the Tube Sheeet

BY R. B. VAN WORMER
General Foreman, Atlantic Coast Lines, Waycross, Ga.

IN presenting this paper on the subject of handling and applying locomotive tubes, it is not the intention to attempt to lay down or describe a method of tube handling ideal in all details and applicable to any or all locations. The most desirable procedure as a whole for a given point should embody and provide for numerous details characteristic to that location, including requirements from dependent outlying points, average life of the tubes as compared with the machinery, variety in the size and length of the tubes required, labor conditions and rates, oil or coal fuel, etc. Not only shop methods and different materials used, but operating conditions, tonnage ratings, grade percentages, etc., prevailing on different roads or districts all have their influence affecting the tube situation, service and economy that may be obtained, and indirectly the best shop practice to follow.

It is safe to say no other item on a railroad presents greater possibilities for improved economy than the tube problem on a road where the subject has not been handled with considerable thought and preparation. It might also be safe to say there is no other item on a good many roads which has received less study and special consideration. To get down to a working basis the total number of tubes there are in continual service should be determined, together with the percentage of new tubes purchased, the percentage that must be scrapped on account of pitting, corrosion or thinness, the proportional cost of any water treatment used as compared to the saving in the tubes affected, the mileage obtained between safe-ending, shop and engine house costs for removing and replacing tubes in boilers, shop costs for safe-ending tubes, and engine house costs for working over tubes in service.

New Tubes Purchased.—Large savings can be made by keeping the number of new tubes purchased each year down to a minimum. In considering this item it is only fair to include as new tubes, those contained in any new power purchased during the year. Consider 500 engines averaging 280 tubes each or a total of 140,000 tubes in service, a reduction from 6 to only 5 per cent of this total in new tubes purchased would mean a saving of approximately $3,000 per year in material. Under what might be considered average water and road conditions, it has been demonstrated as possible to reduce the yearly purchase of new tubes to as low a figure as 5 per cent of the total tubes in service. The new tubes should always be ordered for the largest engines and those which carry the highest pressure. After they have been used in this service they can be used in the next size of engine where the length and the steam pressure are somewhat less, and so on down step by step until they are utilized in the smallest and lowest pressure engines available. They may perhaps even then be used in part for stationary pump boilers, before being consigned to fence railings, material for making washers, or scrapped, proper credit in any case being allowed.

Method of Handling Tube Work.—The expense of working the tubes has been greatly reduced by the practice of welding them to the back tube sheet when they are installed. The tube work for engine houses or small outlying points should include only the removing and the resetting in the boiler. The tubes should be cleaned, safe-ended, swedged, and cut to length where possible, in the general repair shop. New tubes should be ordered only by the general repair shop, where all records and the best facilities for preparing them may be maintained. Where the tube work for the entire road is done at the main shop the tube department assumes a position of large importance. It should be carefully organized and a well defined plan of operation should be established. Where the life of the tubes between safe-ending averages from 40,000 and 50,000 miles and the mileage between general shoppings is 80,000 miles, it will be apparent that the service of the tubes will not keep pace with that of the machinery. This condition is generally met by renewing the entire set of tubes when the engine undergoes general heavy repairs in the back shop (including internal inspection), and again renewing the bottom half of the set during engine house repairs after the engine has completed half of its mileage. The engine house or outlying repair point should ship the tubes so removed to the general repair shop to be cleaned, safe-ended, cut to length and returned in quantities equivalent to two full sets. These figures, of course, will vary somewhat under different conditions, but the idea is to make the time for the installation of the full set of tubes come during the period of general repairs, to localize all tube work in a tube department at the general repair shop, and at the same time reduce to a minimum the tube work at all other points.

In districts where good water is available the tubes should run the three-year limit or more. The practice of welding the tubes to the back tube sheet has also materially reduced roundhouse work to tubes while in service. The average tube mileage under these conditions will keep pace with the machinery mileage. If during general repairs careful examination shows that three-year-old tubes will be serviceable for as much as 20,000 miles or more by only being worked over, request for government time extension will be justified all things considered, due consideration, of course, being given to the class of service to which that particular engine belongs, and its accessibility for repairs on the district to which assigned. If the various federal inspections and reports were made on a mileage basis rather than a time basis, there is no doubt that the time of boiler repairs could be thrown even more in harmony with the proper time for machinery repairs.

SHOP PRACTICE FOR GENERAL RENEWAL

When an engine has made its mileage it is sent to the general repair shop, with a report from the division on which it operated, giving the general shop information concerning any unusual condition of the engine. Assume that the locomotive under consideration in a saturated engine with boiler containing 336 two-inch tubes and a large quantity of scale; that an internal inspection is due; that the steam pipes and dry pipe are in good condition and tight, and that all other repairs are of such nature as to make the time for renewing the tubes a measure of the time the engine is out of service. The engine having arrived at the shop, the tank is cut loose, the contents of the boiler discharged through the blow-off cocks, and the engine backed onto its designated pit in the erecting shop. Each pit is provided with crane service from overhead, and pipe connections below, leading directly into the pit at convenient locations, for hot and cold water,

*Taken from a paper presented before the Southern & Southwestern Railway Club.

compressed air, acetylene gas, terminals for electric welding and terminals for electric lighting. Proper and reliable illumination is a necessity for economical tube setting, as well as other interior boiler repairs. The extension cord for lights should be of any good grade of packing-house cord which is water-proof and eliminates short-circuits and time killing light failures.

First Operations.—Considering the fact that the practice of welding tubes to the back tube sheets adds from one to two days to the time required for setting the tubes without welding, and also that internal inspection may develop certain boiler repairs that had not been contemplated or provided for in the shop schedule, it is essential that the tubes be removed from the boiler just as soon as possible after the engine is placed in the shop. With this in view, the front end is opened first and the spark arresting arrangement removed, all parts being wired together and tagged. The dome cap and exhaust stand are then removed by a machinist and the steam pipes are tested to determine definitely if they should come out. At the same time a boilermaker enters the firebox and cuts off the tube beads with a thin flat chisel and a No. 3 chipping hammer. Ordinarily this operation should require about four hours for a set of 336 tubes with the beads welded to the sheet. When the steam pipes are not removed the smoke box front should not be removed.

Removing the Tubes.—The same boiler maker with one helper then cuts off the tubes just inside the front tube sheet, using a tube cuutting-off machine propelled by air. In cutting off the tubes with this machine, the helper operates the air motor, while the boiler maker applies and removes the cutter heads. Two cutters are used, one to be removed, applied and started by hand, while the other is cutting by power. In case the steam pipes are not removed, all the tubes with possible exception of three or four in each top corner can be cut off by shifting the machine and supporting bar to the right and left over the door studs. When all tubes are cut off, the fourth tube hole from the top in the center row is reamed out to not over 2¼ in. in diameter, preferably 2⅛ in., depending upon the amount of scale on the tube. Through this hole the tubes are passed out of the boiler. The cutting of the tubes and preparing the transfer hole should require not over five hours. When the steam and dry pipes are removed the transfer hole is, of course, not needed, the tubes being passed out through dry pipe hole. The same boiler maker now returns to the firebox end and drives the tubes out of the back tube sheet with a No. 3 air hammer. At this time he has two helpers, one of whom enters the boiler through the dome to pass the tubes out through the transfer hole, while the other helper, in smoke-box, takes the tubes and loads them onto a specially arranged tube car. Not over five hours should be consumed by the one boiler maker and the two helpers for this work. The tube car is placed on a portable stand in front of the smoke box so that the tubes may be easily loaded and that the work will not require the services of more than one man. This arrangement was described in detail in the July, 1912, issue of the American Engineer on page 357. The tube car is designed to be carried by an overhead crane, or pushed along on its own four wheels on standard gage track. It can also be tiered on top of another car, thus greatly economizing in space at storage track. Another important feature in its design is that it can be quickly unloaded either on the floor or on elevated rail benches by raising one side with the crane, allowing the contents to roll out gently. All the tubes now being removed from the boiler, the helper in the front end pilots the car to tube shop. The helper inside the boiler remains and scales the shell, using a No. 1 pneumatic stone hammer equipped with wide, flat chisel. This work will take on an average of 4 or 5 hours, according to the condition of the boiler.

New Tube Lengths.—The boiler maker again returns to the front end and knocks out the rag ends from front tube sheet with a No. 3 air hammer. He also trues up the tube sheets if necessary and reams out any tube holes found 1/32 in. or over out of round with a special reamer and air motor. It should not require over one hour to knock out the stub ends from front sheet, and it is an exceptionally bad sheet that cannot be trued up in one hour by one boiler maker and helper. The tube lengths are then obtained with the assistance of the helper inside of the boiler. The new tubes should be 7/16 in. longer than the distance over the tube sheets, 3/16 in. of this to be at the firebox end and ¼ in. at smoke box end. From one to four different lengths are taken, a special wood stick with a hook at the end being provided for this purpose. The different lengths are numbered on the stick together with the engine number. The boiler maker also marks on the smoke-box the number of the tubes with their respective lengths and checks off on the tube sheet the areas covered by the different lengths. He personally delivers the dimension stick with any necessary explanation to the man operating the cutting-off machine in tube shop. The stick is retained here until after the tubes are reset, and serves as a check to place the responsibility if any tubes are found cut to the improper length. It is most important to have some simple but ironclad practice for obtaining the correct length of the tubes, as otherwise it will interfere with the plan of operation and cause delay.

Preparing the Tube Sheets.—The boiler maker then cleans out any scale in the back tube sheet holes, using a file. In extreme cases a very light application of the roller expanders will crack and shell out the thin and extremely hard scale sometimes found. The holes in a new back tube sheet should be made 1/64 in. smaller than the nominal outside diameter of the tube and both inside and outside edges of the hole should be countersunk sufficiently to remove the sharp edges, but not more than 1/32 in. The holes in new or part new front tube sheets should be made 1/32 in. larger than the nominal diameter of the tube, and they should be similarly countersunk. The copper ferrules are then applied to the back tube sheet. Their outside diameter should be such that the ferrules will fit the hole tightly and they should be set in an exact position by a straight sectional expander having a small shoulder which seats against the face of the sheet so that the ferrule will extend 1/32 in. out from the face of the tube sheet. In some localities it is the practice to set the ferrules with a special tool before expanding it into the hole with the sectional expander, but this is an unnecessary operation. When expanding copper ferrules with the standard ferrule expander, a hammer not larger than a chipping or No. 3 size should be used. The copper ferrule is set back 1/32 in. to prevent working the ferrule out under the bead when working the tube, and particularly to prevent inferior welds when welding the beads to the tube sheet. The ferrules should be ⅝ in. long for tube sheets ½ in. thick, and of a size to suit the size of the tube hole, always maintaining the swedged end of the tube to 1⅞ in. outside diameter. They should be of the best soft annealed seamless copper. To clean and prepare the holes for the ferrules, and apply and secure them, should not require more than four hours with one man.

Placing the Tubes.—In applying the tubes to the boiler, the boiler maker is, at first, given two helpers, one of whom is on the car containing the safe-end tubes and passes them to the boiler maker in the smoke-box. The other helper is inside of the boiler. When the steam pipes are not removed, the tubes going back of the steam pipes are first entered and placed by the inside helper in their respective holes, care being taken not to damage the copper ferrules. All tubes back of the steam pipes and several horizontal rows at the bottom are thus located and started in their ferrules, until there is no room left for the helper inside. He then goes to the smoke-box, and the boiler maker goes to the firebox.

The balance of the tubes, commencing at the bottom, are now shoved through their own holes by the two helpers at the front end, while the boiler maker enters them in their respective ferrules by means of an iron rod.

When all the tubes are in place, the second helper leaves the work, taking the empty tube car with him. The remaining helper assists the boiler maker to spot the tubes, using a bar with a shoulder to drive against at the front end and a gage at the back end to accurately locate the end of tubes 3/16 in. from the firebox face of the sheet. New tubes are only added to those sets which are applied to boilers that have not had the steam pipes removed. These new tubes being in perfect condition should always be installed in the most inaccessible locations such as behind the steam pipes so as to reduce to a minimum inconvenient removals in case of failure during hydrostatic test or later. As each tube is accurately set 3/16 in. from the tube sheet, the edge of the projecting tube at just one point is slightly turned over by one or two light blows with a special hammer, the striking face of which is something similar to a narrow fuller. This ensures no movement of the tube when starting the expander, and it requires no one at the front end to back up the tube. Accurately locating all tubes in the boiler, including those transferred ready for expanding, requires four hours upon the part of the boiler maker and two helpers.

Fixing the Tubes in the Tube Sheets.—The tubes are now ready for tightening in the sheets. The helper is removed from the work, the boiler maker being given the assistance of another man, usually an apprentice. The tubes are first expanded with a straight sectional expander in connection with a long stroke hammer. One man operates the air hammer without it leaving his hands, while the other manipulates the expander and mandrel. The expander pin or mandrel should be driven into the straight expander until the tube is solid against the ferrule and the sheet. The tubes are then run over with a standard flaring tool used in connection with a long stroke hammer, the ends being flared enough to allow the standard sectional prossering expander to enter sufficiently to get the prosser fillet just inside the water side of tube sheet. This also bells the tube sufficiently to start the bead with the beading tool after it has been prossered.

The tubes are prossered with the standard sectional expander, the pin of which is driven in tight, slacked off, and the expander turned slightly in the tube and driven in again. This should be done at least three times, or until the tube is properly set. All tubes should be carefully inspected to ensure that the recess in each tube has reached the full depth of the boss on the expander and is even all around the tube. When tightening the tubes to the back sheet no oil should be used if they are to be welded, for electric welding is decidedly unsuccessful if oil or even traces of oil is on the work. An oil soft soap, such as linseed soap, should be used as a lubricant, the remaining traces of which are much more easily removed than oil. To expand, flare and prosser the full set of tubes with the long stroke hammer should require not over eight hours' time for the boiler maker and apprentice.

The tubes at the front end are expanded with the standard front end flaring tool, consisting simply of a tapered pin. Not over thirty minutes is required for this operation, after which the boiler maker returns to firebox, beads the tubes and prepares them for welding, leaving the apprentice and a helper in front end to roll the tubes with an air motor. In performing these operations at both ends at the same time, the beading follows the rolling of each tube.

After beading the tubes with the standard beading tool, the operation is repeated with a roughing tool which prepares the bead and sheet for electric welding. This roughing tool is very similar to the standard beading tool, differing only in the design of the heel, which is slightly larger, having its face corrugated by the impression of a coarse file when hot. This operation removes any possible remaining trace of scale or foreign matter on the metals to be welded, as well as presenting a suitable surface for the metal to knit to. This process of brightening or roughing requires about one hour's time.

In rolling the tubes at the front end, a standard self feeding rolling expander is used, the helper operating the air motor. It is sometimes necessary to shim a few tubes at the front end. This is done with unplanished sheet iron peaned down to a feather edge. The rolling of all tubes at the front end averages about 5 hours, whereas beading and roughing requires 6 to 6½ hours; the difference in time of the two operations is consumed by the apprentice in applying the arch tubes and mud plugs in readiness for hydrostatic test.

Hydrostatic Test.—The hydrostatic test is then applied, using water of a sufficiently high temperature to cause any leak to quickly dry on the sheets or shell when they are caulked or otherwise closed up. During this test the tube setters inspect the tubes. The defective tubes, if any, are then removed by splitting, not over 2 in. at the front end and backing out. Ordinarily the amount of defective tubes so removed should not average over one per cent, and being located out toward the center of the boiler where they are easily and readily removed through their own holes, as previously explained, they can be replaced much quicker and cheaper than by testing each tube individually before it is installed in the boiler. The defective tubes removed are smashed over all welds with a hammer to prevent any possibility of a defect in one of the two or three old welds being overlooked and again finding its way back into another boiler. These defective tubes are at once carried to the flue shop by the boiler maker and helper, who obtain an equal number of new tubes without safe ends which, when installed, require no further testing.

WELDING TUBES TO BACK TUBE SHEET

The installation of tubes to boiler is now complete with the exception of the last and final operation of welding the beads to the back tube sheet. This welding can be best accomplished by one of the regularly assigned tube welders of the shop. The work requires continual care and thoroughness rather than great skill. Where a number of welders are employed, the best operator should be the chief welder and his duties should include supervising the welding work as well as instructing or breaking in new welders. He should see that the work is properly prepared for welding, which is most important for good work. When possible it is excellent practice in the back shop to have the chief boiler inspector also be the chief welder, since with this combination all welding is thoroughly inspected from the standpoint of both durability and federal regulations, and tends to discourage any welding which might be considered impracticable or expensive. Welding fifteen 2-in. tubes per hour is a fair average for thorough work for one man. While no hard and fast rules may be laid down as to the size of the electric welding outfit, it may be said that for miscellaneous repair work around general repair shops of about 24 pits, a 600-ampere equipment, which is of sufficient capacity to take care of four operators on metal electrode work, is usually satisfactory.

Cost of Welding Beads.—For tube welding ⅛-in. welding wire of the best Norway or Swedish iron gives the best results. With this material the current runs from 110 to 130 amperes per operator. With 80 per cent efficiency in the motor generator set and on a basis of 15 tubes per hour this would mean an average current consumption of 665 watts per 2-in. tube. Assuming the power to cost 1 cent per kw. hr. the cost for power would be 0.7 cents per 2-in. tube. A good welder will average 18 tubes per pound of ⅛-in. welding rods, which at 8 cents per pound, and the welder's time

at 43½ cents per hour gives a total labor, material and power cost of 4 cents per 2-in. tube.

Flux.—Opinion seems to be equally divided with reference to the use of a flux in connection with tube welding. A series of tests made with and without the use of flux developed no difference in results, but particular care was taken to see that the sheet was absolutely clean. In the case of welding systems where a carbon electrode is used to form the arc, the flux is an important item as it removes, by combination, any carbon carried over from the carbon electrode. However, this does not apply in the case of metal pencil electrodes, where theoretically at least no flux is necessary. Where a flux is used, it is applied most conveniently by making a paste by the addition of a small amount of water to the flux finely powdered, and in which the electrodes are dipped and then allowed to dry.

Welding Operation.—The electric welder first runs over the tubes with an acetylene torch just sufficiently to burn off any trace of the linseed soap lubricant of foreign matter which may possibly have collected there. This does not require over 20 minutes time. If at any time the sheets get wet, they must be dried or inferior welding will result. Each tube as welded is also again brightened by means of a stiff wire brush to remove any possible trace of rust or red oxide which so quickly collects on the surface of the new metal from the hot water during the hydrostatic test. Care should be taken that the voltage is not too high. High voltage makes it easier for the operator, but it is not good for the tubes, as the operator with high voltage keeps the metal pencil ½ to ⅝ in. from the sheet, and the metal only sticks and does not weld. A voltage of 65, with 125 amperes, makes the operator get within 3/16 in. from the sheet, which is the correct distance for most efficient welding.

When welding the tubes, it is desirable to start with the top horizontal row and weld across row after row. This protects the unwelded tubes from the effects of the fumes and gas which escape from the arc. The weld of each individual tube should be started at the bottom, building on upon each side of its circumference to the top. If it is desirable to particularly rush the work of welding, two operators can be used on the tube sheet and wall panel, partitioning them off from each other by means of a canvas curtain suspended from a rod inserted in one of the top tubes. After the tubes are welded, it is unnecessary to go over and smooth up the beads. Such practice may possibly present an appearance more pleasing to the eye, but if anything is detrimental rather than beneficial to the welding. The tubes should be welded after the hydrostatic test to prevent loss of time and welding labor, in case of possible failure in some of the safe-end welds. After the electric welding is completed the boiler should then be filled again with water, but only at the shop line pressure, which usually is at least 50 lb. It will be found that this pressure is amply sufficient for the second test.

When electric welding old tubes which have seen not over one year's service, the same methods are employed, after doing what working over the tubes may require. For old tubes a simple and efficient sand blast may be used. This will clean the set in 30 minutes, care being taken not to use too much sand. The operation of burning off the beads with the acetylene torch can be omitted.

LABOR REQUIRED

It is to be noted with this schedule of operations, the set of 336 two-inch tubes have been removed and renewed complete, ready for service, without removing the steam pipes or dry pipe in 37 hours by one mechanic, with the assistance during this time of one helper for 10 hours, two helpers for 8 hours and one apprentice for 13 hours, and then finally an electric welder for 21 hours.

SUPERHEATER FLUES

For superheater flues the same method of removing and applying is followed; the operations for setting, expanding, beading and rolling for superheater tubes is the same as for boiler tubes, except the superheater tubes are beaded over at both ends. The holes in new sheets are 1/32 of an in. larger than the nominal diameter of the flue. The copper ferrules should be of a diameter suitable for the flue and No. 13 gage. No ferrules should be used at the front end, but steel shims may be used when necessary.

ARCH TUBES

As the installation of brick arch tubes is similar to tube work, it is good shop practice to include the arch tube work in the tube setter's work. In removing arch tubes, they are burnt off close to the inside of the tube and door sheets with the acetylene torch, and the stub ends carefully split with the torch taking care not to injure the sheets in so doing. They are then readily closed in and knocked out into firebox with hammer and chisel from the outside. After the arch tube plugs have been removed, four 3-in. arch tubes can be removed, by this method, in 30 minutes. Any scale in the arch tube holes can readily be removed with a round file. The old arch tubes removed should be carefully examined and if in good condition, which is frequently the case, they can be used again in the next smaller size firebox, first annealing the ends.

New arch tubes should be ordered 2 in. longer than is absolutely required. After being heated and bent to a standard template for the particular class of engine, they are placed in position in the boiler, gaged for brick, and the exact lengths laid off, allowing the ends to project exactly ¼ in. beyond the tube sheet. This method necessitates cutting off of one end only, which is done on power driven cold saw. Arch tubes of seamless drawn steel tubing ¼ in. thick give the best results. No ferrules are used. After arch tubes have been cut to exact length and placed in their exact position in boiler, the boiler maker with one helper expands the ends tight into the sheet. The ends of the tube should be annealed and the expanding done with the proper sectional expander with special extended mandrel.

In case of new sheets requiring new arch tube holes, the holes are cut after the sheets are in place in the boiler, using the acetylene torch with cutting nozzle secured to a special compass device. This process enables the work to be done very quickly, about 3 minutes per hole. In the case of the outside tapped holes, it can be done sufficiently accurate as to not even require reaming out. The holes securing the arch tubes are smoothed up with air driven reamer requiring about 30 minutes per set of eight holes. Old threads in the outside holes should always be cleaned up with the proper tap, first building up the holes by autogenous welding if necessary to maintain the standard size. After the tubes are expanded in place, the projecting end of the tube is lipped over against the sheet at all points in the circumference, a long stroke hammer and a round three-edged tool being used for this purpose. This process requires very little time and makes a substantial and secure job.

TOOLS FOR SETTING TUBES

It is hardly necessary to state to any modern railroad of today that to keep down the cost and at the same time maintain the highest degree of efficiency, it is necessary that methods be standardized for all tube work in the different shops and engine houses. This of course refers to both the methods of application and the materials used. Instructions must be issued and carried out to insure uniform methods and tools being used; tubes installed at one point must be worked over at another point with tools that fit, otherwise the life of the tube is rapidly shortened. To insure this standardization, all tools and all gages for tools should be

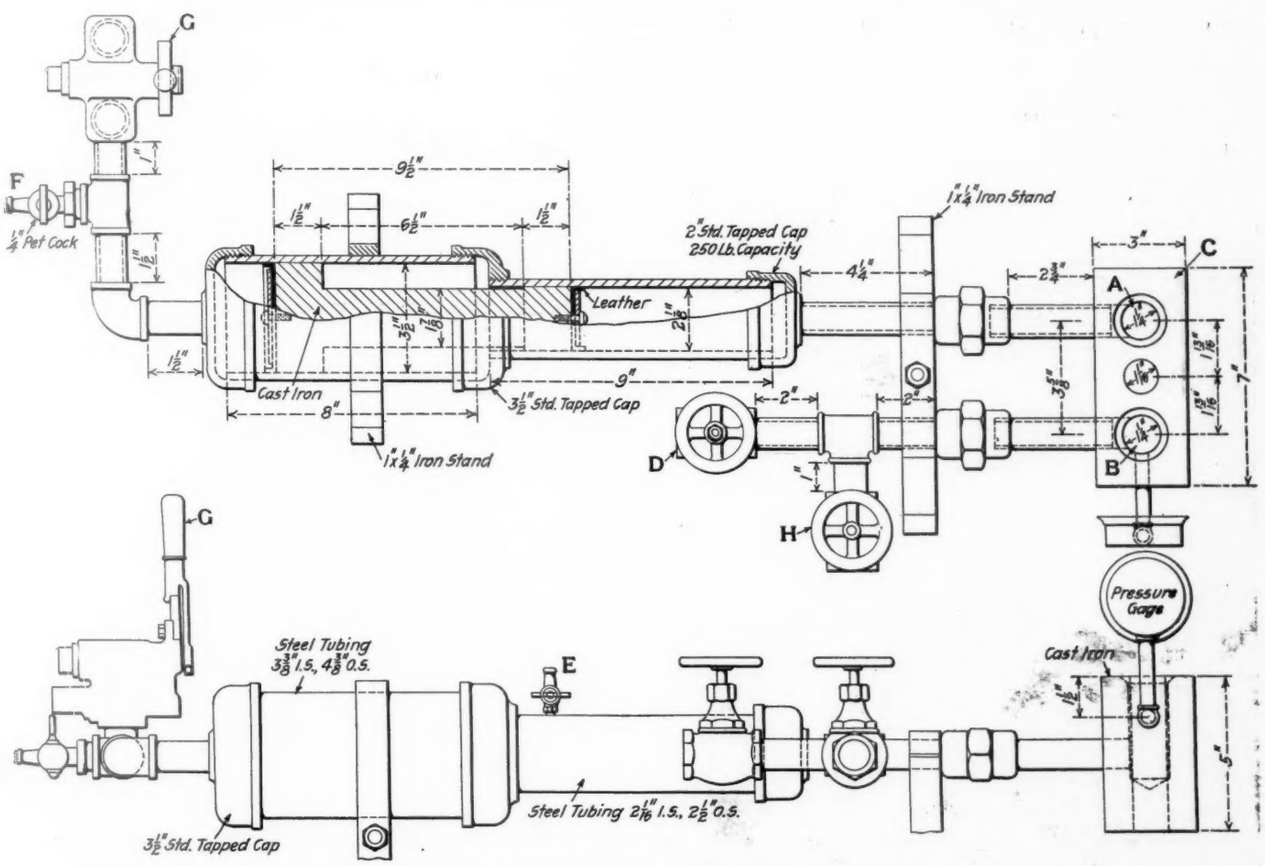
made by or furnished from the general or main shop, at which point master gages are kept; they should not be shipped to the outlying points on their requisitions until after carefully inspected and passed upon by some competent person. All standard gages for beading tools, mandrels and expanders should be available only at the main shop.

All beading tools should be checked at least once every thirty days by the boiler maker foreman or some equally competent person, to see that they conform accurately to the standard gages. Beading tools not conforming to the gages should be returned to the main or distributing shop for repairs. Beading tools should not be repaired at any outlying points. The tools when made should be marked with some suitable identifying symbol, as for example S-1, to S-5 for the straight sectional expanders, or P-1 to P-5 for prossering expanders, the number designating the purpose for which the tool is intended, and also enabling the shop men to specify exactly the standard type desired.

SUPERHEATER UNIT TESTER

The accompanying illustration shows an arrangement for applying the hydraulic test to superheater unit tubes. This was designed and made at the Silvis shops of the Chicago, Rock Island & Pacific. It is made up almost entirely of standard pipe fittings with the joints on the high pressure side of the small cylinder arranged to withstand a pressure of 250 lb. per sq. in. The large cylinder of 3½ in. diameter is made from steel tubing. In this is located the cast iron plunger, the other end of which operates in the other cylinder of 2⅛ in. diameter, also made from steel tubing. The unit pipes are clamped to the header block *C* by a bolt.

Water from the shop supply is admitted through the valve *D* until the system is filled and the plunger is pushed to the extreme left. The pet cock at *E* relieves the air pressure in front of the water on the high pressure side, and the pet cock *F* relieves the air pressure on the air side. With the system filled the water supply valve *D* and both pet cocks are closed. The straight air valve *G* is then opened, permitting the air from the shop line to enter the large cylinder. The difference in the diameter of the cylinders creates a pressure of water over two and one-half times that of the air, thus permitting a 250-lb. test pressure to be obtained. A pressure gage is located in one end of the header block. After the test has been made the air pressure is removed and the system is drained through the valve *H*. Two header blocks are made, one with the holes *A* and *B* 3⅝ in. apart, and one with them 4 in. apart, for two styles of superheater unit tubes used. Pipe connections on both blocks are made the same, so as to be interchangeable with the rest of the apparatus. These blocks are made of cast iron.



Hydraulic Tester for Superheater Units

A CENTERING MACHINE

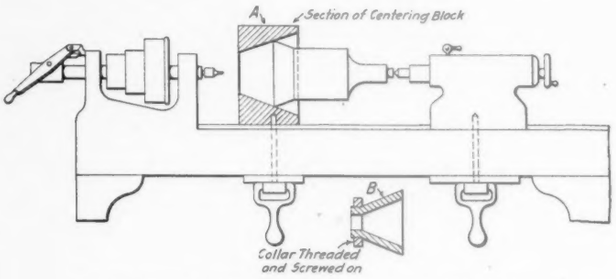
BY E. F. GLASS

The accompanying sketch shows a device for centering pins of larger diameters than can usually be accommodated on the ordinary centering machine. In use it has proved to be both rapid and accurate.

It is made of a small speed lathe, fitted with a sliding spindle and lever. It has a head block *A*, which has a taper bore varying in diameter from 1¾ in. to 3½ in. The larger diameter of the bore should be 1-16 in. greater than the head of the largest pin to be centered. The device will center pins from the largest to the smallest diameter of the bore in the head block without any adjustment and if desired, an aux-

iliary bushing which is turned to fit the block as shown at *B*, may be applied for smaller work.

In operating the machine it is only necessary to adjust the tailstock to conform with the length of the pin to be centered. Then the head of the pin is placed in the bore of the block *A* and run up by the tailstock center until it fits tightly in the hole. The chuck on the end of the spindle is fitted



Centering Machine Developed from an Old Lathe

with a combination center drill and it is only necessary to pull the lever forward to force the drill into the head of the pin and form the center hole.

This machine has been used for centering pins which have been partly finished in the turret lathe and has materially reduced the time required for this operation.

MAKING STEAM PIPES BY OXWELDING METHODS

BY W. H. HAUSER
Mechanical Engineer, Chicago & Eastern Illinois

A short time ago the Chicago & Eastern Illinois had occasion to equip two locomotives with Schmidt superheaters, and as there were only three engines in the class, a study was made to see if the steam pipes could be obtained without

Fig. 1.—Castings from Which the Steam Pipes for the Superheater Locomotive Were Made

making new patterns. These patterns would cost approximately $55 to $65 each, and would be used at rare intervals after the original application. It was found that the upper portion of the steam pipes for the Mikado superheater en-

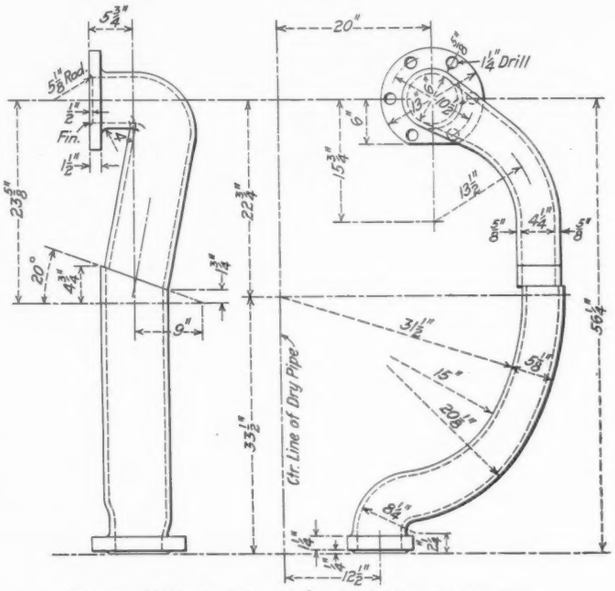


Fig. 2.—Method of Cutting and Welding Steam Pipes

gines could be used with the lower portion of the steam pipes removed from engines being converted, by welding them together by the oxweld process. The steam pipes of the Mikado engines were of the outside type. Fig. 1 shows the two steam pipes used; the one on the left is that taken from one of the engines being converted and the one on the right is the Mikado steam pipe.

Fig. 2 shows where the steam pipes were cut and how closely they matched. The pipes were laid off according to

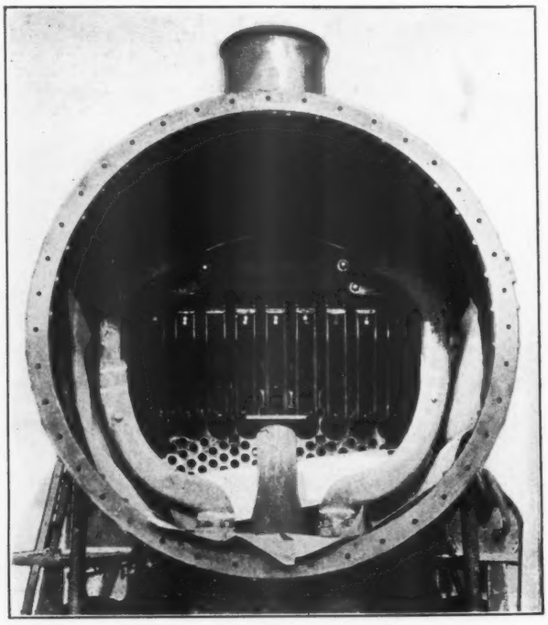


Fig. 3—Welded Steam Pipes After Testing

the drawing, and were then set on a slotter and cut to the line. The two sections were completely machined and then placed in the engine, bolted in place and adjusted to the

proper fit. The two sections were then tied together by welding them at opposite points for a distance of about 1½ in. The pipes, with the sections thus fastened together, were then taken down and the welding operation completed. The pipes were welded at a cost of about $1.50 each. The cost of the new Mikado pipe was approximately $12 with salvage from the lower half of about $3, making the cost of the new pipe approximately $9 plus $1.50, or $10.50, whereas had new patterns been made the pipe castings alone would have cost more than the entire cost by this method. The application of the steam pipes in the superheater engine after the pipes were welded is shown in Fig. 3.

In another case it was desired to convert a locomotive of the cross compound type, the only one of its class, to a simple engine. In order to make the change it also would have been necessary to make two new steam pipe patterns, but this was obviated by using a combination of steam pipes in a way similar to that described above. Fig. 4 shows this installation. The original tee-head in the engine was a three-bolt tee-head. A standard four-bolt tee-head was applied and

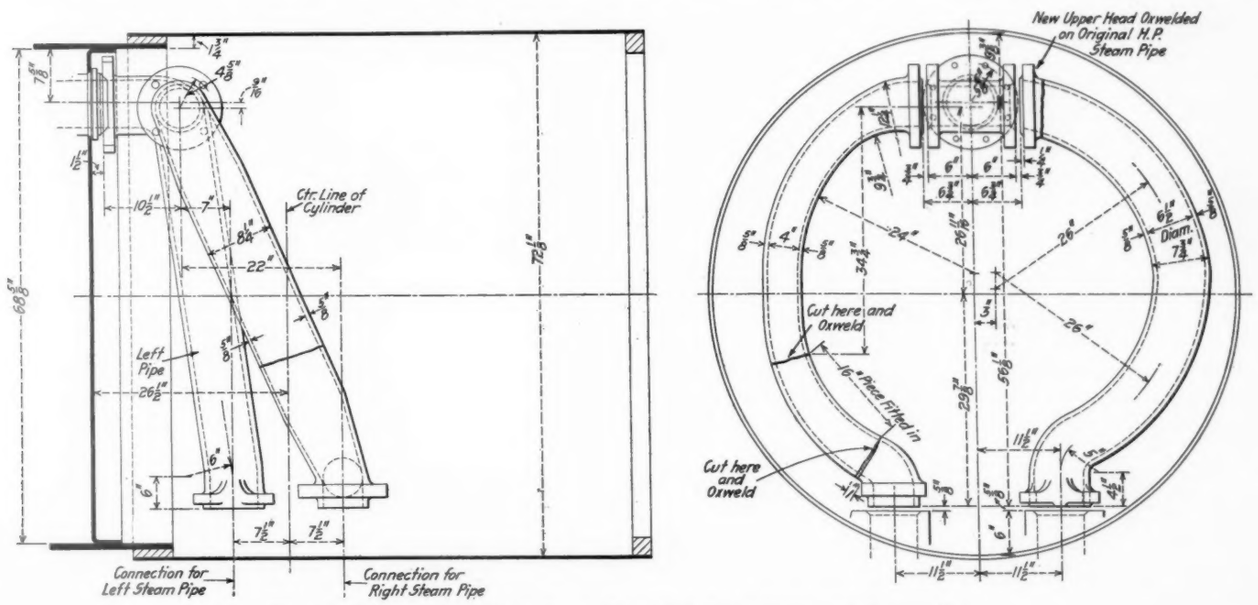

Ctr. Line of Cylinder
Left Pipe
Connection for Left Steam Pipe
Connection for Right Steam Pipe
New Upper Head Oxwelded on Original H.P. Steam Pipe
Cut here and Oxweld
16" Piece Fitted in
Cut here and Oxweld
Diam.

Fig. 4—Welded Steam Pipes for a Converted Cross-Compound Locomotive

the top flange of the original steam pipe was cut off and a flange from a right hand steam pipe, of which there was a pattern, was welded on. This made the left hand pipe complete at a cost of about $1.50. The right hand pipe was made from a new right hand pipe of which there was a pattern. This was cut just below the center, as shown, and a 16-in. section from the pipe from which the upper flange for the left pipe was obtained, was welded on. To this was welded the lower flange from the original cross compound pipe, which was to be scrapped. In other words, two right hand pipes were used to furnish sufficient material to make the two steam pipes for this engine. The sections of these pipes were also assembled on the engine and partly welded in place and then taken down to complete the welding operations. These steam pipes have all given very satisfactory results and undoubtedly saved a considerable amount by doing away with the necessity of making expensive patterns.

A GOOD BOILER TUBE RECORD.—That high rates of driving are not detrimental to a boiler provided it is accompanied by proper supervision needs no better proof than the fact that the Interborough Rapid Transit Co. has a record of fourteen tube renewals a year out of sixty-four boilers.—*Power.*

BOOSTING THE GENERAL FOREMEN'S ASSOCIATION

Two of the letters received in the competition on the "Benefits Derived from Convention Attendance" were from members of the International Railway General Foremen's Association, and are as follows:

BY C. L. DICKERT
Assistant Master Mechanic, Central of Georgia, Macon, Ga.

What benefits have I derived from attending General Foremen's conventions? Representatives from practically every railroad in the United States and Canada are in attendance and each has something good to offer. My object in attending is the good I get out of them, and I have never come home without something that more than paid the expenses of the trip, and the results were almost immediate. On some occasions methods were described by men located at or near the place of meeting, that I wanted to see in actual operation. I took a side trip with but little expense, thus not only bringing out the advantages of the practice in question more clearly, but getting me in touch with other good practices.

At these conventions we meet and talk with the best informed railway mechanical men in the country, and they talk freely of what they are doing.

To enumerate all the good I have received from attending the conventions would take too much time and space; one instance must suffice. At one of the conventions I learned of a tool used in another shop that cut the time on certain work from hours to minutes. This one thing alone was well worth going after.

The good I get when attending these conventions is not confined to any one department, but covers both locomotive and car departments. I have been able to solve some knotty problems by talking with men from different roads. Something is wrong with the man who takes an active part in the meetings of the General Foreman's Association, and is not benefited thereby.

BY W. W. SCOTT
General Foreman, Delaware, Lackawanna & Western, East Buffalo, N. Y.

My personal experience with railway mechanical associations covers a period of years, but I will confine myself to what I know about the International Railway General Foremen's Association and the opportunity offered its members

to advance in their chosen field by close attention to reports and discussions on shop and roundhouse efficiency and better shop methods which increase shop output at a reduced cost.

One of the best arguments is the book entitled "Shop Kinks" published by the *Railway Age Gazette*. This interesting and valuable book, containing all the best shop kinks up to the time of publication, was the result of several discussions on shop kinks and efficiency at a meeting of the General Foreman's Association; by taking advantage of the ideas contained within its pages, I was able to reduce my cost of output in some cases 30 per cent.

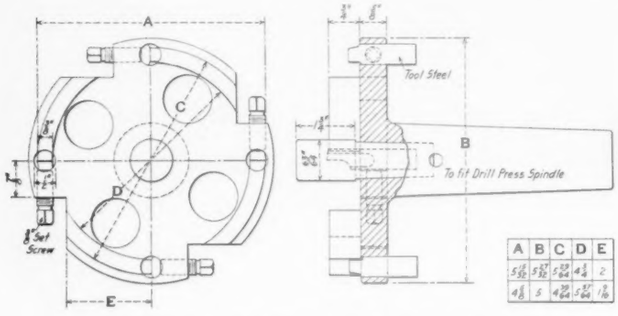
One item in particular might be interesting as an illustration. I found that a roundhouse machinist would lose 35 minutes each nine-hour day in going from his work to the tool room for the wrenches used in his work. We had fifteen machinists at that terminal. In other words, out of 15 the railroad paid and gave away the services of one full paid machinist. This extravagance was removed by introduction of portable tool boxes. It saves labor and gains the company the use of one more mechanic without increasing the payroll.

The limit of 750 words placed on "Booster" articles prohibits me from mentioning other items. All mechanical organizations in general, and the General Foremen in particular, point with reasonable pride to many of their members who have ascended the ladder of opportunity with nothing back of them but their dogged persistency to learn and absorb the best offered at the convention.

Railroads want efficiency, and usually get it, but the average efficiency of a railway shop or engine house is low. It has the practice that comes with a day's work, that's all. A progressive foreman is not satisfied with just a day's work to his credit but wants to know what other men are doing in the same line of endeavor. A trip to the convention brings him back with new ideas to increase the shop output. He is enthusiastic in his work and eventually by his convention activities pays the railroad a substantial dividend on the expense money invested.

TOOLS FOR CUTTING HOLES FOR SUPERHEATER FLUES

The special cutter shown below is designed for cutting and chamfering the holes for superheater flues in one operation. The shank is made to fit the drill press spindle, and is hollow to receive the pilot pin. The body of the tool is turned in the lathe, with the collar, as shown, extending ¼ in. below the disk. The four recesses are then shaped out and the holes for the tools and set screws are finished, after which the



Tool Which Cuts and Chamfers Holes in Flue Sheets

parts of the collar in front of the tools are cut away. The collar thus supports the tools, so that there can be no pivot chattering.

Two tools, set at diametrically opposite points and shaped as shown in the dotted lines, cut the hole through the sheet and the other tools chamfer the edge to a radius of 1/16 in. The pilot pin can be made of any size desired. At the shop where this tool is used it is the practice to drill a one-in. hole in the flue sheet and a pilot pin of 63/64 in. diameter is used.

SOME ARC WELDING INFORMATION*

II

BY F. G. SAUSSURE†

Perhaps no other machine tool of recent years has made such a great impression upon the mechanical world as has the electric welder, and there are few men engaged in the repair or manufacture of iron or steel commodities who are not more or less familiar with its use.

De Meritus, in 1881, seems to have been the first to employ the electric arc for welding, but little is known of his experiments except that a carbon electrode was used. The Benardos carbon electrode process was a later development and is still employed for certain classes of work.

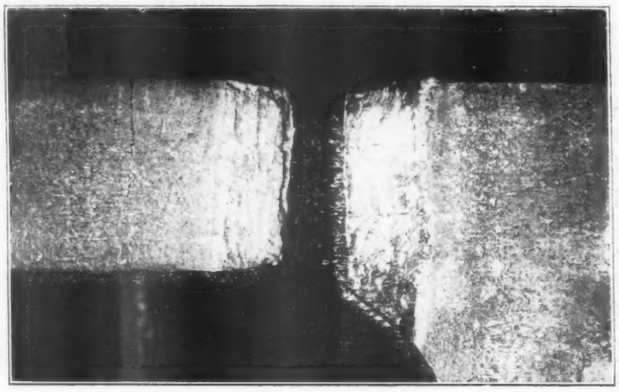


Fig. 1—A 6-In. by 8-In. Frame Section Prepared for Arc Welding

The carbon electrode process has the disadvantage that carbon is deposited in the welds, therefore little, if any, machining can be done because of hard and brittle metal. Besides this, the work is limited to a downward position since it is a puddling process. These objections were overcome by Slavianoff‡ when he developed the metallic pencil process, which is now in most general use.

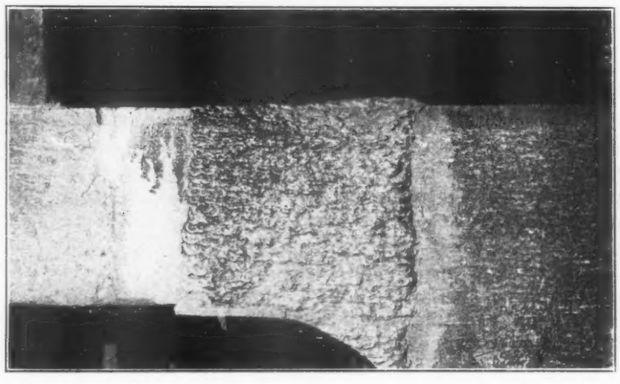


Fig. 2—The Frame Weld Completed

GENERAL USES

Practically every railroad in the United States uses electric arc welders, and on some systems nearly every shop

* The preceding article was published in the *Railway Mechanical Engineer*, for February, 1917, page 95.

† Engineer, Siemund-Wenzel Electric Welding Company.

‡ For a discussion of the carbon and metal electrode processes, see the November, 1916, issue of the *Railway Mechanical Engineer*, page 591.

and roundhouse has been given the "putting on tool" that was suggested to the man who "took too much off" or drilled a hole incorrectly. Nearly every part of a locomotive or car subject to wear or breakage has been repaired by arc welding, and the illustrations show a few examples which give an excellent idea of the enormous savings that may be obtained by this process.

A frame of 6-in. by 8-in. section can be prepared and

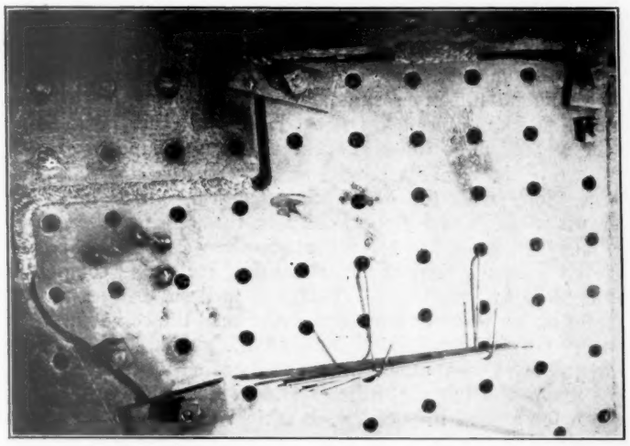


Fig. 3—A Firebox Patch Tacked in Place for Arc Welding

welded (Figs. 1 and 2) in about twelve hours. By the blacksmith method, where the engine was stripped to take the frame to the fire, or oil burners were used to weld in a "Dutchman," the time required was from three to seven days, and the cost over $200 as compared with about $20 for the electric process. The firebox that needed a patch or a new half side sheet once gave the boilermaker foreman grave concern, but now, as illustrated in Figs. 3 and 4, the

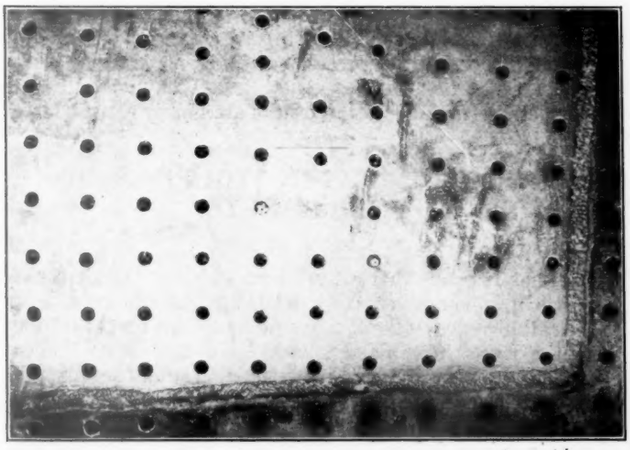


Fig. 4—A Completed Firebox Weld

proposition is not so serious. Locomotive cylinders (Figs. 5 and 6) are welded with savings even more pronounced than in the case of a frame or fire box.

Tubes, however, present the most striking example of the use of electric welding, for since the advent of the welded tube it is not uncommon for a set of tubes to remain in a locomotive until the limit of the time allowed by law. One trunk line furnishes figures showing 20,000 miles per tube failure before welding compared with 50,000 miles per welded tube failure.

Not only on railroads, but in marine repair work, the electric welder has for a long time held an important place and one in which the principal requirement is reliability of the repairs made.

COST OF WELDING

The relationship between power intake at the motor generator and metal applied at the weld has been found to be from 2.2 to 2.6 kilowatt-hours per pound of metal applied. With a welding current of 175 amperes, about 3.28 lb. of electrodes are used per hour. In the previous article it was shown that 54 per cent must be added to the volume of the opening to find the amount of welding metal required and that 26 per cent of the electrode is wasted in stub ends.

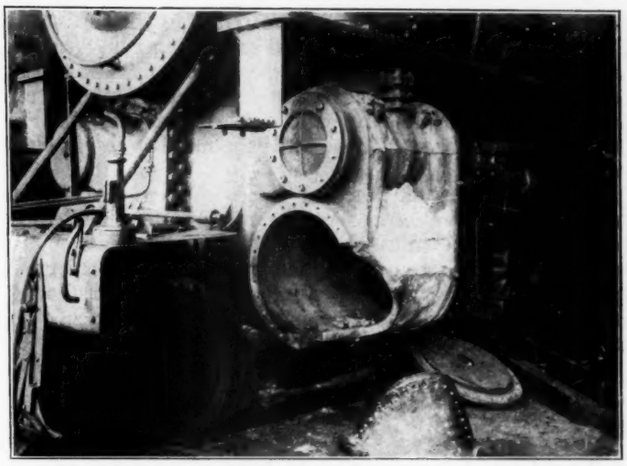


Fig. 5—Broken Cylinder Which Was Repaired by Arc Welding

If the volume of the opening should amount to 5 lb. of metal and we increase it by these percentages, it will take about 10 lb. of electrode to do the work; at 4.28 lb. per hour, the time required will be about three hours, and at 2.4 kilowatt hours per lb. of metal applied (which is 54 per cent over 5 lb.) there will be 18 kilowatt hours, at a cost of about 30 cents. The cost of electrodes at 6½ cents per lb. is 65

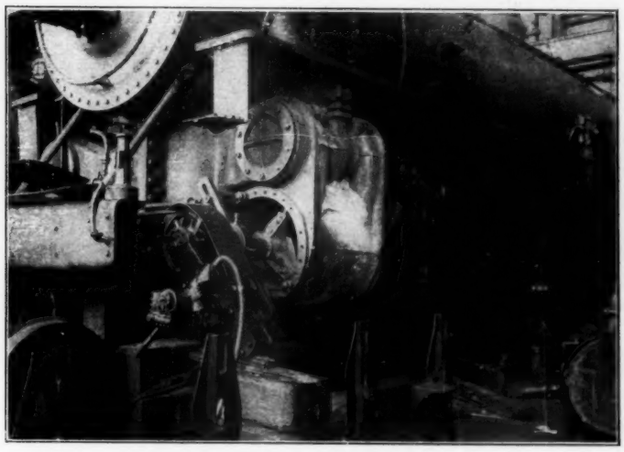


Fig. 6—Reboring the Welded Cylinder

cents. To these charges must be added the cost of labor and overhead, which will more than double the total.

ELECTRODES

There is a definite relationship between the size of electrodes and the proper amount of current to be used. Welding current ranges from 70 to 160 amperes and electrode sizes from ⅛ in. to 5/16 in. It is also of importance that the electrodes be of the best quality. The electrodes should be

clean and bright and of uniform size and chemical composition, and for general work the carbon content should be low. Bad welds are sure to result from the use of improper materials. The best electrodes are those made of either Norway or Swedish welding iron, or certain brands of similar composition manufactured in this country. A little manganese in the welding material does no harm, but the presence of phosphorus or sulphur has the same bad effect as in other iron and steel products.

USE OF FLUX

The pro and con of the use of flux has been much discussed, but though the writer is a firm believer in its use it should be a question for the individual to decide. There is no question of its value in a weld as made in a blacksmith's fire, but the conditions are altogether different. The objects of flux as claimed by advocates for electric welding are two-fold: It purifies the weld, and it excludes the air, thereby preventing oxidation, while the metal is in a molten condition.

Several brands of prepared fluxes are on the market, or one can mix his own flux, according to formulas easily obtainable from manufacturers of welding apparatus. To use the flux the powder is mixed up with water to form a paste, the electrodes are dipped into the mixture and allowed to dry. A few minutes in the morning will be sufficient time for the operator to coat electrodes for a day's work.

A NOVEL PLANING DEVICE

BY J. W. HOOTON

A useful tool for planing cylinders is the extension head designed by the writer and used in the N. C. & St. L. shops at Nashville, Tenn. It is designed for finishing cylinders on a planer which will not permit the casting to pass under the cross rail. The extension head is applied to the planer by removing the tool post apron and fastening the extension casting to the head with 1⅛-in. studs. The construction,

Extension Tool Posts for Planing Cylinders Which Will Not Pass Through the Planer Housings

which is very simple, can be readily seen from the short extension shown on the side head of the planer. The tool at the end can be set to any position and by turning the head a cut can be taken at any angle, which makes it possible to plane the cylinders in the most convenient position and thus saves time.

The upper extension head is 48-in. long and a shorter arm 36-in. long, used for planing the exhaust seats, is applied to the side head. This tool has been in use for 15 months and has planed over 30 cylinders. It has given no trouble and the work has proved to be accurate.

WELDING HIGH-SPEED STEEL TIPS TO TOOLS

BY J. G. FRASER

Many roads have reported good success in the welding of high-speed steel tips to lathe tools by the electric and acetylene welding systems, but welding under pressure by the use of a compound has been confined to the smaller sized tools. However, the Canadian Pacific has developed a method which is giving satisfactory results at the Angus shops, not only on small shanks but also on wheel lathe and other large tools. The method is as follows: The shank is ground or shaped to receive the high-speed steel and is then placed in the furnace along with the high-speed steel tip, which has been drawn to shape and ground clean on the welding face.

They are heated to a red heat, or about 1,500 deg. F., removed from the furnace and cleaned of scale, and compound is applied to the shank. The tip is then set on and placed under an air press and pressed down until the compound has firmly adhered to both the tip and the shank. The tool is then replaced in another furnace and heated up to 2,000 deg. F., removed from the furnace and placed under the press again for a final pressure, after which it is cooled off under the air blast, or it can be cooled at atmospheric temperature with very good results.

The shanks may be drawn down from old axles or tires, or, if they must be purchased, steel with from .30 to .50 carbon is the most satisfactory. This welding is applicable to any kind of tools regardless of their use; wheel lathe tools which are used in extraordinarily heavy service stand up as well as the smaller tools. The percentage of losses is approximately 2 per cent; that is, two tools fail in every hundred welded, and this is discovered in the smith shop by a simple test system.

The cost of oxy-acetylene welded tools is, material 61 cents, labor 35 cents, a total of 96 cents. The electric process costs, for material 23 cents, labor 15 cents, a total of 38 cents. The welding compound process costs, for material 10 cents, labor 11 cents, or a total of 21 cents. This method effects a considerable saving and the results are highly satisfactory.

REPAIRING CRACKS IN THE FLANGES OF TUBE SHEETS

BY DANIEL CLEARY

It oftens happens that a flue sheet which is in fair condition has troublesome cracks extending from the rivet holes to the calking edge of the flange, and also short cracks leading from the rivets towards the knuckle of the sheet. These conditions are usually found where the flue sheets are fastened with cone head rivets and sometimes the flue sheet will be found to have drawn away from the side sheet. The method of repairs given below has been used successfully to overcome the trouble due to these conditions.

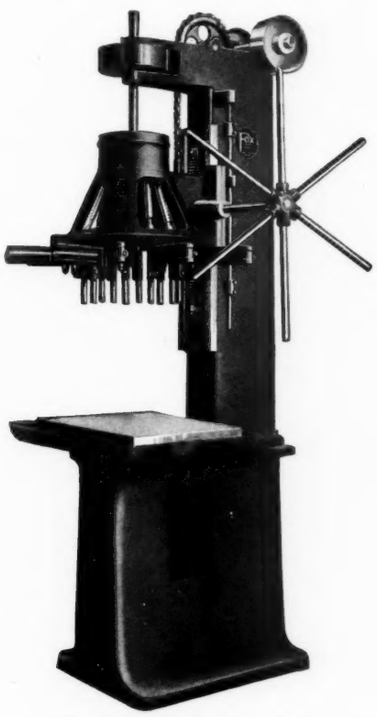
The heads of the rivets should first be cut off, but the rivets should not be backed out of the sheet. The flanges should then be scarfed with a pneumatic hammer from the rivet holes to the calking edge of the sheet, leaving the sheet about half the thickness of the plate at the calking edge. All the rivet holes should then be countersunk. If the flue sheet has drawn away from the side sheet, heat the flange with an oil burner and when the proper heat has been secured, remove the burner and put machine bolts through the rivet holes where needed, then draw flue sheet up to its place and hammer it so that it will fit up well against the side sheet. With good workmanship, this method will prevent further trouble from the cracks in the tube sheet.

New Devices

FOX SENSITIVE MULTIPLE DRILL

A small, inexpensive, sensitive multiple spindle drilling machine to be used for light drilling, counter sinking, etc., has been placed upon the market by the Fox Machine Company, Jackson, Mich. It is of simple construction and was brought out to fill the urgent need for a machine that could take care of the multitude of light jobs of drilling, counter sinking, etc., for which the heavier multiple drills are not well adapted.

The machine as regularly built is shown in the illustration, but if it is desired to be used as a bench machine, the base can be mounted on a thin base plate. The column and base are of box construction, with the table cast separate, so that various size tables or special fixtures can be placed on the base. The table has a wide oil flange and an oil drain pocket, with T-slots in the flange to receive clamping bolts securing jig stops to the table. Hyatt roller bearings are used upon the idler pulleys and the drive pulley on the vertical shaft



Fox Sensitive Multiple Drill

runs in bronze bushed bearings, end thrusts being taken up by ball bearings.

The machines are designed to take drills up to ½-in. in diameter and are furnished with either 9-in. or 12-in. round heads which can be equipped with from two to ten spindles one-in. in diameter or from two to sixteen spindles ¾-in. in diameter. All pinions have double bearings turned integral with the pinions and the gears run in an oil bath.

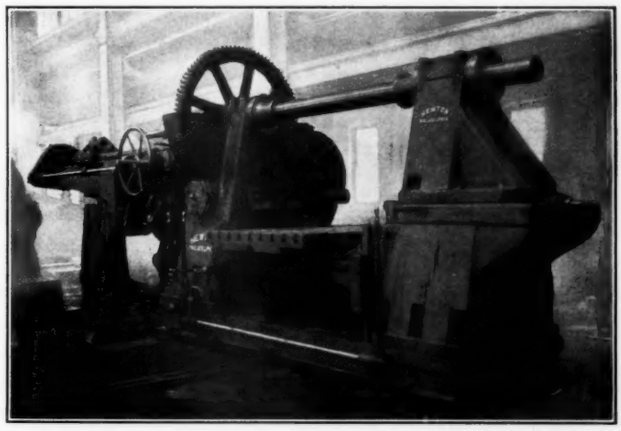
The adjusting arm is of a new type which permits the adjustment to be made very quickly and holds the bearing securely to the arm. The universal joints are of the Fox patented type which are composed of three parts only, no pins, screws or rivets being used in their construction. The drill spindles are of crucible steel. Sufficient provision has been made for the thrusts upon the ball bearings to reduce the strain at this point.

The builders are prepared to furnish cluster plates for these machines for use on complicated layouts where the regular type of arms cannot be used.

LOCOMOTIVE CYLINDER AND VALVE CHAMBER BORING MACHINE

With a view to eliminating the time lost in resetting cylinders when boring piston valve chambers, the Newton Machine Tool Works, Philadelphia, has lately developed a machine which retains all the special features of its standard cylinder boring machine, but has an unusually large range of adjustment for the table, both vertically and laterally.

This machine, like the former design is adapted to boring and facing both ends of the cylinder at the same time at the most rapid rates permissible with high speed tool steels. The spindle is 7 in. in diameter, has 12 ft. of gear feed and hand adjustment and a rapid power traverse in both directions. In order to permit using small boring bars



Newton Cylinder and Valve Chamber Boring Machine

for boring the valve chambers, the end of the spindle is fitted with a large taper with retaining and drift key slots.

The spindle is caused to rotate in unison with the spindle sleeve by means of a double spline and full length keys. The sleeve revolves in cap bearings, so arranged that the driving worm wheel is supported on both sides. The worm wheel engages with a hardened steel worm, fitted with a roller thrust bearing and both are arranged to be submerged in a bath of oil at all times. The worm wheel drive is particularly advantageous when boring work with intermittent surfaces, such as is encountered in facing the ports of locomotive cylinders as any spring, due to the release of tension under heavy cuts, is taken up by the angular teeth.

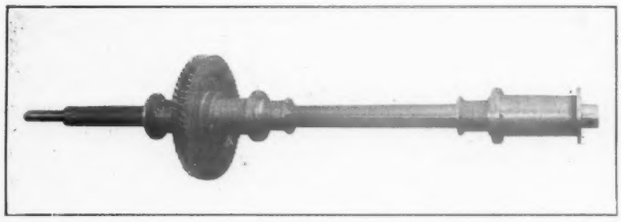
The bearing which carries the facing arm is cast integral with the spindle sleeve and as this bearing carries no key it is possible to bore while the facing heads hang stationary

in their usual position, or the facing and boring may be accomplished simultaneously. The engagement of the facing head for rotation is accomplished by swinging a lever attached to an eccentric clamp. The facing head bearing on the sleeve in the outboard spindle bearing is similar to that on the main spindle sleeve.

The work table is 54 in. wide by 72 in. long and has 30 in. of hand cross adjustment. The minimum distance between the center of the spindle and the top of the work table is 39 in. and the maximum distance 51 in. The maximum distance between the ends of the facing heads is 60 in.

The drive is so arranged that the fast power traverse of the spindle may be used while the spindle is not rotating. This feature, together with the rotation of the spindle and the power elevation on the table are operated by levers located on the table of the machine, both along the side of the main head and the outboard bearing, and may be disengaged or engaged without stopping the motor.

For driving the machine, the use of a motor of at least 20 hp. is recommended. With a motor speed of from 400 to 1,200 r.p.m., spindle speeds of from three to nine r.p.m. can be obtained and feeds per revolution of spindle from .0637



A Spindle and Sleeves Removed from the Machine

to 1.019 in. are available. The reversing quick power traverse of the spindle provides speeds of from 9 ft. to 36 ft. per minute.

The approximate net weight of the machine is 70,000 lb. and the over-all floor space occupied is 31 ft. 6 in. by 9 ft. 6 in., this including the extension for the motor bracket.

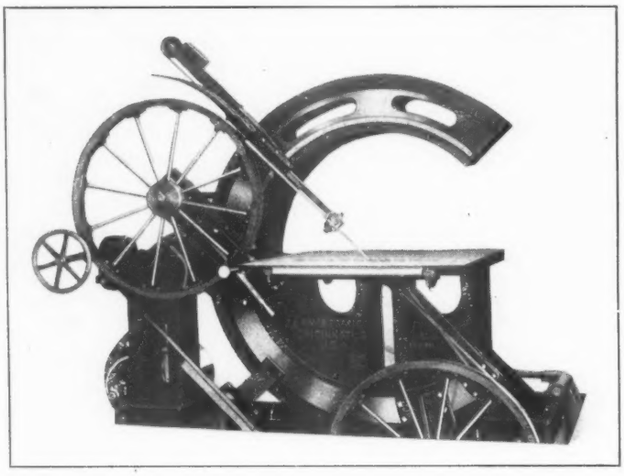
A SHIP BAND SAW

A ship band saw for extra heavy sawing, on both straight and curved work, has recently been built by the J. A. Fay & Egan Company, Cincinnati, Ohio. It is designed particularly for use in ship yards, but will also be found useful in railroad car, bridge and pattern shops.

This machine saws to any angle in a full semi-circle, the wheel being carried on a housing mounted on roller bearings and adjustable at any angle up to 45 deg. either right or left of the vertical. The blade may be adjusted by power or hand while the machine is sawing. The wheel shafts are mounted in self-alining ball bearings. The column is a massive one-piece casting with broad floor bases, designed to carry the wheels without vibration at any angle. An auxiliary column at the rear carries the angling mechanism. The face of the main column is planed and fitted with roller bearings to carry the saw carriage, guides, etc. The table is of iron 48 in. square, and is fitted with rollers to facilitate handling the stock. It is rigidly mounted on the main column and is therefore always level.

The wheels are 48 in. in diameter with a 3 in. face to carry blades of any width up to 3½ in. They are made with steel spokes and laminated wood rims, faced with rubber. Both wheel shafts are mounted in self-alining ball bearings with provision for vertical adjustment, side lining and tracking the blade. Both wheels are mounted on a heavy circular carriage, gibbed to the main frame with provision for taking up wear. This carriage travels on self-lubricating, roller bearings mounted in the main column, making the angular adjustment easy. An index is provided to show the exact angle of the saw blade. As the wheels move simultaneously and always in the same plane about a center coinciding with the intersection of the blade and the table surface, the cutting point of the blade is always at the same point on the table surface, regardless of the angle. The straining device is sensitive, compensating for any irregularities and may be set at any tension required for different widths of blades.

The Fay & Egan type guides are furnished, the upper guide being mounted on a square post with a self-contained counterweight. The space between the guide and the table is 24 in. when setting vertical and 16 in. at the extreme angles. The automatic take-up is arranged to maintain the proper tension on the belt at any angle. The power angling device is controlled by means of a handle at the operator's position and is provided with a device which may be set to stop the angular movement automatically at any desired



Band Saw with 90 Deg. Angular Adjustment

point. A handwheel provides means for giving a very close setting.

For driving the machine a 15-hp. motor should be used. It may be belted to the main driving pulley or if desired, can be direct-coupled to the drive shaft, in which case a motor of 600 r.p.m. is recommended.

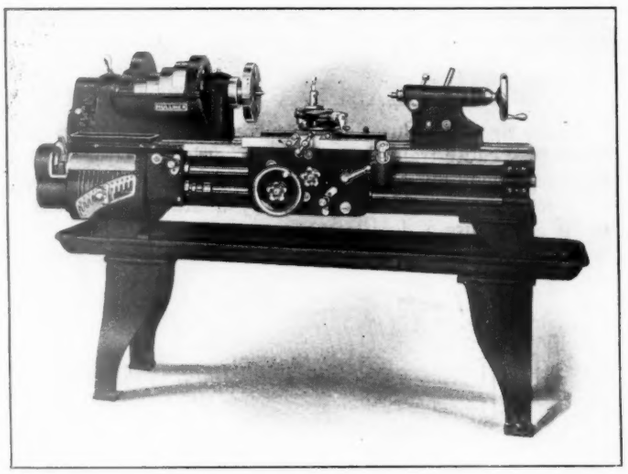
MULLINER QUICK CHANGE LATHE

In the illustration below is shown a small lathe manufactured by the Mulliner Machine Tool Company, Inc., Syracuse, N. Y., which has been designed for extreme rigidity to adapt it to work where accuracy is essential. The machine is built in two sizes, the 12-in. which is fitted with standard beds of four, five and six ft., and the 14-in. which has standard beds of five and six ft. The swing over the carriage is 7½ in. in the 12-in. model and 8¾ in. in the 14-in. model.

The bed is double walled in the cross girths and ribbed transversely, forming a very rigid construction. As the metal on the ways is harder than that on the carriage bearings, the wear which takes place is largely confined to the carriage, so that the accuracy of the machine is not impaired. The carriage has an unusually wide bridge and long vees. The apron is made in a double wall section, giving all important studs and shafts an outboard bearing. The compound rest is rigidly designed, with full contact surfaces and full length taper gibs, having end screw adjustment.

The quick change gear mechanism, mounted on the front of the machine, gives 37 different threads and feeds. The cone gears of the quick change mechanism are cut with the improved Brown & Sharpe 20 deg. involute cutters, forming

a pointed tooth slightly rounded at the top. This is the most satisfactory form of tooth to use in a tumbler gear mechanism, as it permits instantaneous engagement of the gears without clashing, and also provides a stronger section than 14½-deg. teeth. To permit of the application of extra change gears for the purpose of cutting special or metric threads, these new

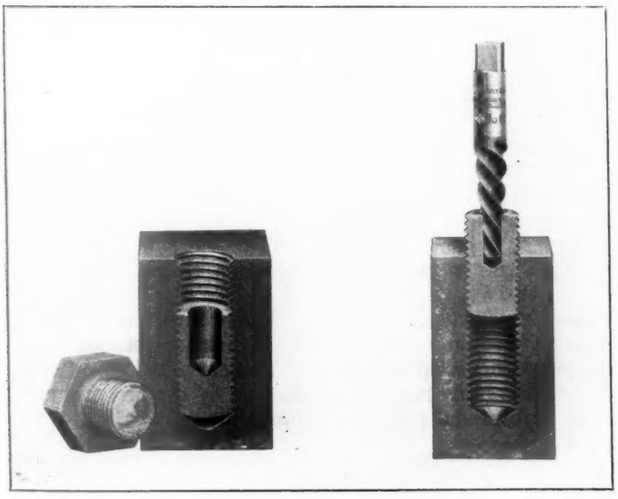


Mulliner Quick Change Lathe

pattern lathes are provided with an auxiliary quadrant, which is located on the end of the bed and carries the gears connecting the head with the quick-change mechanism. The drive is through a four-step cone pulley and a double friction counter-shaft is regularly supplied with all lathes. The standard equipment does not include taper attachment, but it can be provided if desired.

REMOVING BROKEN STUDS

A tool for removing broken studs is shown in the photograph. It will be noted that it has a thread in the shape of a helix, which is left handed. In case it is desired to remove a broken stud, a hole is drilled in the outside end of the stud with as large a drill as possible. This hole should be deep



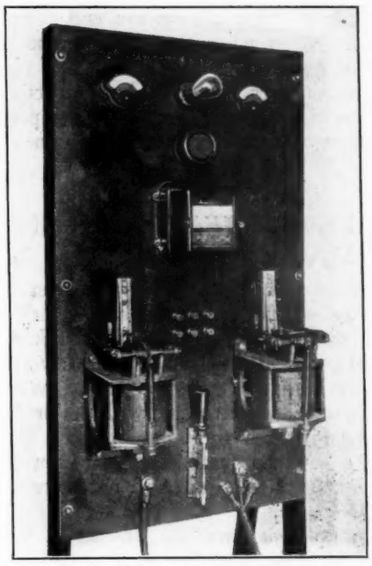
Broken Studs Being Removed

enough to give the stud extractor a firm grip when it is introduced. By turning the tool in a left hand direction, the extractor is driven into and grips the stud, and the broken bolt may be turned out. If the stud is very tight in the hole the edge of the thread will bite into it and grip tighter, the angle of the thread being such that it will not act as a cutting tool.

The tools are made by the Cleveland Twist Drill Company, Cleveland, Ohio, and come in sets of three different sizes, thus providing for the removal of studs of a considerable range in size.

CONSTANT CURRENT, CLOSED CIRCUIT ARC WELDING SYSTEM

Arc welding practice as it exists today is based on the operation of arcs from constant potential circuits and since arcs operated under these conditions are unstable, it is necessary to connect in series with each arc a ballast resistance. The arc welding generators operate at from 60 to 70 volts. A normal welding arc consumes about 22 volts and any voltage produced by the generator in excess of this must be absorbed in resistance and wasted. Arcs which are operated in multiple require a separate circuit from some point where the voltage regulation is close and, on account of the expense of low voltage distribution circuits, practice has tended toward the single arc unit, portably mounted.



Individual Arc Panel

The Electric Welding Company developed in their practice a new system of arc welding and the Arc Welding Machine Company, New York, has perfected the system, now known as the constant current, closed circuit system, which operates arcs in series.

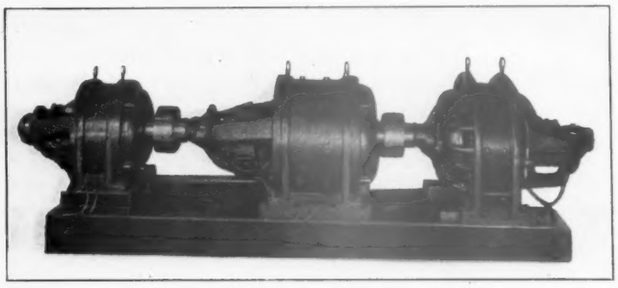
This method has all the advantages of series distribution, namely, the size of wire is uniform throughout the system and carries a uniform current independent of the length of the circuit, as well as of the number of operators. The circuit is simply a single wire of sufficient cross section to carry the current for one arc, run from the generator to the nearest arc, from there to the next, and so on back to the generator. Wherever it is desired to do welding, a switch is inserted in the line and a special arc controller provided with suitable connections plugged in across the switch whenever work is to be done. These controllers may be made portable or permanently mounted at the welding station.

The generator is a special machine and consists of two units, the generator proper, which furnishes the energy for welding, and the regulator, which automatically maintains the current at a constant value. The regulator is excited from a separate source and by varying its excitation with an ordinary field rheostat, the main welding current may be set at any value within the range of the machine, and once set it will automatically maintain that value.

Each arc that is operated on the system is equipped with an automatic controller, which serves two essential purposes. First, it maintains at all times the continuity of the circuit so that one arc cannot interfere with any of the others when it comes on, or goes out of the circuit. Second, it controls automatically the heat which can be put into the metal of the weld. The current through the arc is adjusted by shunt-

ing any desired portion of the main current around the arc. The regulation characteristic of the arc is adjusted by a series-parallel resistance, which is patented.

Provision is made in this system for stopping the arc whenever the voltage in the arc exceeds the predetermined value, which is adjusted to suit the work and the operator.



Motor Generator Set With Regulator

This makes it impossible to draw a long arc and burn the metal. The arc is not broken when the welding operation is stopped, but is killed by a short circuit which is placed across it. The number of arcs that can be connected in series is limited only by the voltage, but up to the present time 12 is the maximum number for which machines are constructed.

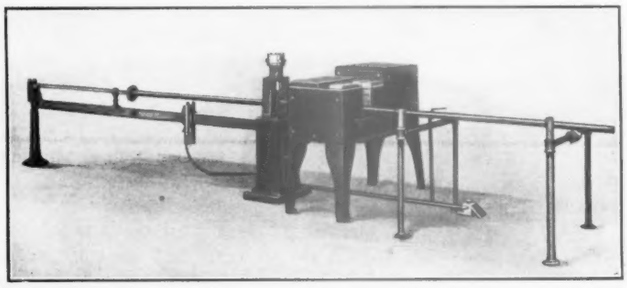
RYERSON BOILER TUBE RECLAIMING MACHINE

The reclaiming of old boiler tubes has in the past been given very little consideration, due in general to the fact that the reclamation of old materials has only been taken up seriously by the railroad companies within the last few years.

Since the railroads have stopped the practice of welding several safe ends to flues, they are confronted with the problem of disposing of a large number of short tubes, which are in good condition and can be used, provided they can be welded together to make up the lengths required with not more than one or two welds.

For the reclamation of tubes by welding, Joseph T. Ryerson & Son, Chicago, Ill., have developed a machine which not only provides a satisfactory flue reclaiming unit, but may be utilized also for the regular safe ending operations.

The machine is of the hammer type with a special mandrel



Furnace and Welder Which Can Be Used for Safe Ending or Reclaiming Flues

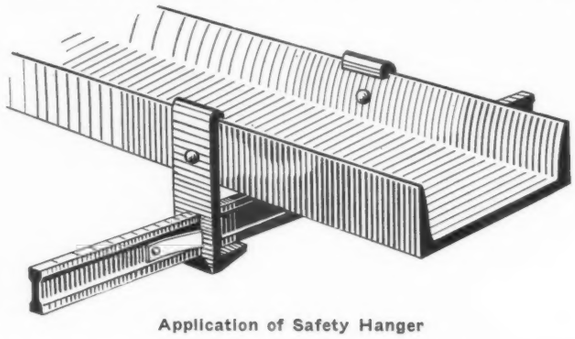
on which the flue is placed. In operating, the tube is heated and belled out in the usual way and the safe end, or shorter tube inserted. The tube with the safe end inserted is then passed through the furnace and over the mandrel until the point of the weld is in the proper place for heating in the furnace. When the desired temperature is reached, the tube is shoved forward through the furnace under the welding dies, the welding machine being in direct line with the furnace opening. A stop or guide is arranged on the mandrel and this acts as a gage to locate the welding point under the dies as well as an automatic starting device. As soon as the pressure of the tube is taken off the gage stop, the air supply is cut off and the welding machine comes to a standstill. The tube is then pulled back through the furnace and the operation is completed.

By the installation of this tube reclaiming equipment a great number of tubes that are at the present time scrapped may be reclaimed with a large saving.

BRAKE BEAM SAFETY HANGER

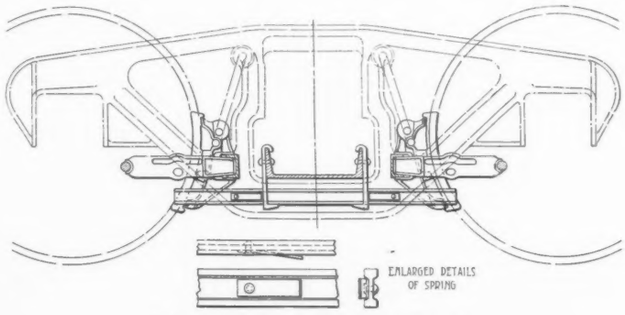
Brake rigging failures are a source of annoyance especially when they cause train detentions. The delay may be but for three or four minutes, yet it counts in the record just as much as a longer one. Also occasionally a brake beam will get down and cause a derailment.

To eliminate these troubles, E. O. Elliott of the Philadel-



Application of Safety Hanger

phia & Reading patented a safety hanger of simple and effective construction.* This hanger has been further developed by the American Steel foundries and the resulting design is shown in the drawings. It consists of two brackets riveted to the sides of the spring plank extending below the spring plank and having a slot in them of a shape to receive the cross rail which acts as a safety guard. There are two springs riveted on to the cross rail with open ends pointing



Safety Hanger in Place On Truck

toward each other. The distance between the ends of these springs is slightly greater than the distance between the two supports on the spring plank. The cross rail can therefore be introduced or removed at pleasure by compressing one of these springs and pulling it through the support.

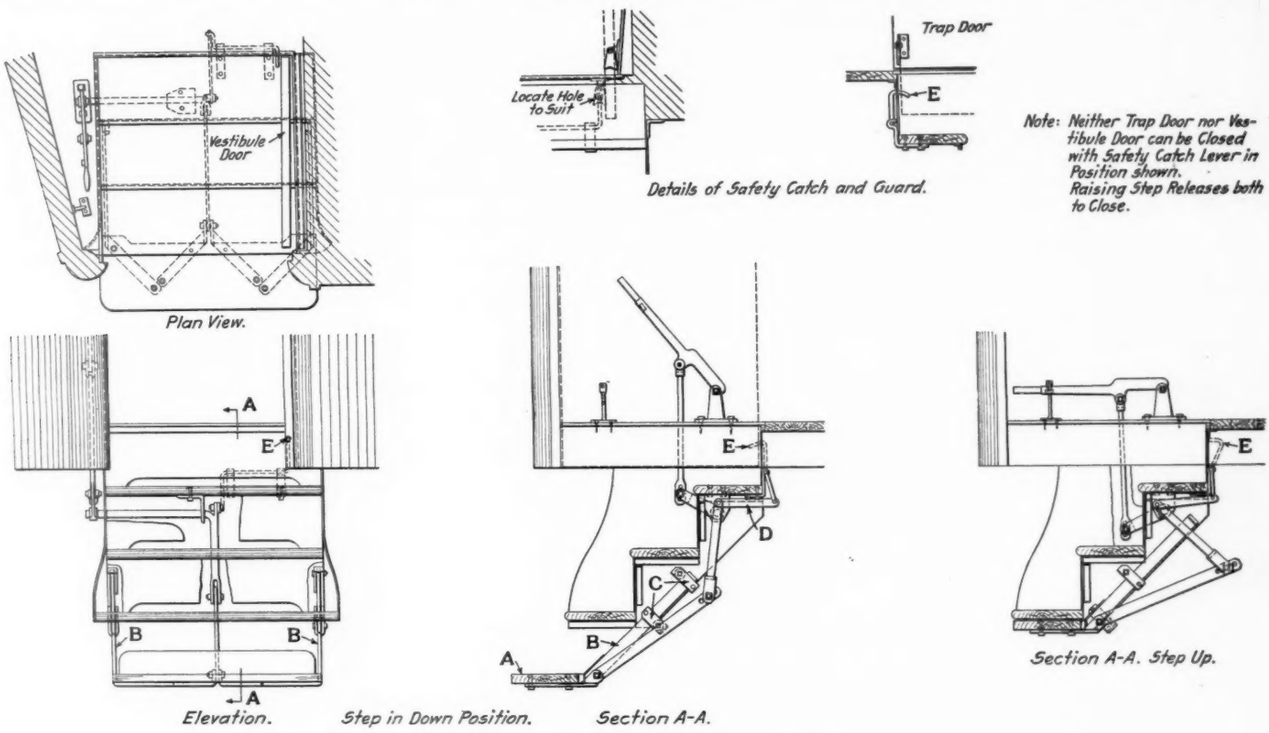
*Original construction described in Railway Age Gazette, Mechanical Edition, August, 1915, page 43.

Hiring and Firing.—The power to hire and discharge extended to a number of individuals has given rise to abuses and friction which have cost the employer dearly. Nothing is more fatal to sound organization than such power without adequate supervision and check. Petty executives should never be entrusted with this vital function. Hiring men and discharging men are serious affairs.—*Engineering Magazine.*

EXTENSION COACH STEP

The Duluth, Missabe & Northern has installed on a number of its coaches the extension coach step shown in the accompanying illustration. The arrangement is operated through a system of levers from the coach platform, the installation shown being that for a vestibule car. The step *A* is supported by the arm *B*, which operates in the bracket *C*. These brackets are attached to the inside of the step support and each contains one roller, the upper bracket having the roller on the upper side and the lower bracket on the lower side. This permits a free action of the supporting arm *C* as the step is raised and lowered. The step is operated by means of a bell crank lever, one end of which is connected by a link to the operating handle, and the other end by a link to the extension step itself. As the handle is raised the step will be lowered, and as the handle is lowered the step will be raised, the action being clearly indicated in the illustration.

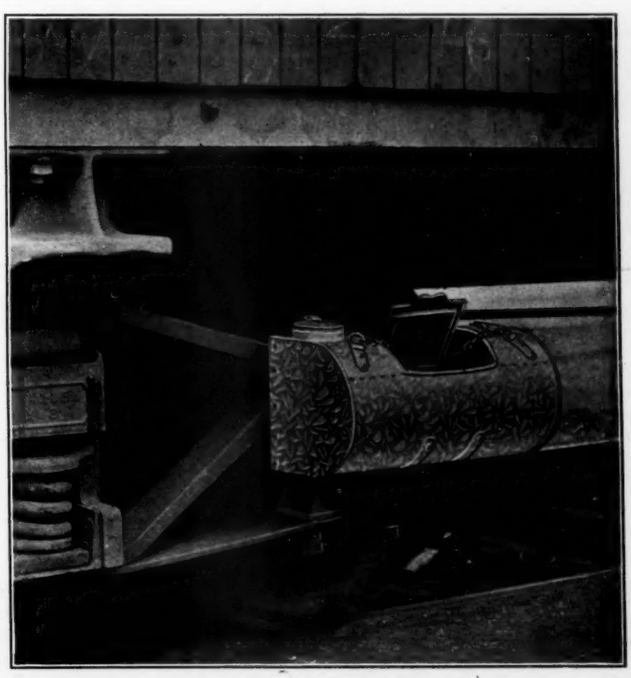
As a safety measure, the device is arranged so that it is impossible to lower the step while the vestibule trap door is down, or to close the vestibule door before the step is up. This is done by means of the link *D*, which is attached to an extension of the long arm of the bell crank lever and which operates the safety catch *E*. This safety catch extends through a hole in the foot stop of the upper step, just below the platform, and on the extreme right. A flat dog hanging loosely on a pivot attached to the trap door covers the hole in the foot stop when the trap door has been fully closed. This makes it impossible for the safety catch to extend through this hole and therefore makes it impossible for the step to be lowered. In case the trap door is closed before the step has been raised the flat dog will rest on the safety catch, thus preventing the trap door from closing sufficiently to permit the vestibule door to be closed. With the step in the up position the handle is locked in a suitable catch attached to the platform of the vestibule. It has been tested with a weight of 910 lb. It was invented and patented by John T. Rodenbur, 218 Fourth Ave., West, Duluth, Minn.



Extension Coach Step for Passengers Cars

JOURNAL BOX COOLER

The Gustin-Bacon Manufacturing Company, Kansas City, Mo., has developed a new type of journal cooler known as the Zero cooler, which is fastened to the journal box only. The Zero journal box cooler has a capacity of 5½ gals. and weighs 12 lb. when empty. It can be attached quickly to the journal box and when applied cannot swing out. The cooler extends out from the journal box only three inches. A chain is used to fasten the cooler in place.



A Journal Box Cooler Which Is Attached Directly to the Journal Box

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CREDIT TO HARVEY DE WITT WOLCOMB

The characteristic style of Harvey DeWitt Wolcomb is so familiar to our readers that there are probably few who did not recognize the story in the February issue of the *Railway Mechanical Engineer*, entitled "A Foreman Who Fired Himself," as coming from his pen. Through an unfortunate oversight, the author's name did not appear over the article and we take this opportunity of giving the proper credit to Mr. Wolcomb.

CLASSIFICATION OF LOCOMOTIVE REPAIRS

In republishing the report on "Classification of Locomotive Repairs," presented before the International Railway General Foremen's Association, in the October, 1916, issue of the *Railway Mechanical Engineer*, page 532, C. S. Williams, foreman inspector, New York Central Lines, was wrongly referred to as shop superintendent of the Pere Marquette. The classification of repairs given in the first paragraph of Mr. Williams' paper is that of the New York Central Lines, instead of the Pere Marquette as would appear from the text.

INCREASE IN M. C. B. REPAIR BILLS

In accordance with M. C. B. Circular No. 31, recently issued by the executive committee of the M. C. B. Association, the arbitration committee has modified M. C. B. Rule 106 to read as follows:

"Rule 106. No percentage shall be added to either material or labor used in repairs to cars prior to January 1, 1917. For repairs made on and after that date, twenty-five per cent shall be added to the net total amount of the bill, for material and labor; this provision to apply to all charges authorized in these rules, with the following exceptions:

"No percentage to be added to charges for repairs made on authority of defect cards issued prior to January 1, 1917, regardless of date of repairs.

"No percentage to be added to bills rendered by car owners for material furnished by them for repairs to their cars on foreign lines.

"No percentage to be added to bills covering settlement for destroyed cars or trucks, under Rule 112."

The above provisions also apply to passenger equipment cars.

PROPOSED LEHIGH VALLEY ELECTRIFICATION

The Lehigh Valley announces that it is making a thorough study of the possibilities and advantages of electrifying portions of its lines through the anthracite region, including the Wyoming division on the main line between Mauch Chunk and Pittston Junction, Pa., and the Mahanoy and Hazelton division, which is a branch line between Penn Haven Junction on the main line and Mount Carmel. The proposed electrification involves 83 miles of double-track main line and 62 miles of double-track branch line, or a total of 145 double-track miles. Based on the cost of similar projects it is estimated that the improvement will involve an expenditure of approximately $10,000,000, including locomotives.

It is understood that no definite decision has been reached as yet. The road is simply studying the situation and particular attention, of course, is being given to those sections of the line which, because of physical and traffic conditions, are most suitable for electrification. It is of interest to note that one of the sections mentioned includes the city of Wilkes-Barre, Pa., which has a population of about 80,000.

The sections of line being considered for electrification are in the heart of the anthracite region of Pennsylvania, which means that both the traffic and the physical conditions of the road are similar to those on the electrified division of the Norfolk & Western. Both the main line and the branch are characterized by heavy grades and curves, and a large part of the traffic consists of heavy tonnage coal trains moving in both directions over the main line, but principally northeast on the branch. The general merchandise freight traffic on this section of the Lehigh Valley is considerably heavier than that of the Norfolk & Western, however, as it passes through a number of fairly large cities.

Electric power necessary for operating the trains will be obtained from both steam and hydro-electric plants, and it is understood that the power will be purchased. The use of electric power will make it possible to burn a cheaper grade of coal in stationary power plants than is required for steam locomotives, and a considerable saving will thus be effected.

MEETINGS AND CONVENTIONS

Car Inspectors' and Car Foremen's Association.—At the executive committee meeting of the Chief Interchange Car Inspectors' and Car Foremen's Association held in Chicago February 23, it was decided that the next annual convention would be held in St. Louis in the latter part of September.

Railway Storekeepers' Convention.—At a meeting of the executive committee of the Railway Storekeepers' Association in Chicago on February 12 it was arranged to hold the fourteenth annual convention at Chicago on May 21 to 23, inclusive. Committee reports will be presented on the handling of rail, the handling of cross ties, the reclamation of scrap and other subjects. Special attention will also be given to the proper handling of materials distributed along the line, supposedly for immediate use and representing an investment of millions of dollars. An elaborate report will also be presented on the handling of stationery. In addition the committee is planning a number of interesting and novel features for the convention, which will contribute materially to its success.

New York Railroad Club.—The next meeting on Friday evening, March 16, 1917, will be annual electrical night. Edwin B. Katte, chief engineer electric traction, New York Central, the chairman of the committee in charge, has arranged an attractive program. L. E. Johnson, president of the Norfolk & Western, will address the club on the "Economic and Operating Features of the Electrification of the Norfolk & Western" and R. Beeuwkes, electrical engineer of the Chicago, Milwaukee & St. Paul, will present a paper on "The Peculiar Engineering and Structural Features of Electrification on the C., M. & St. P." The club committee is endeavoring to arrange for an operating official of the railroad company to give a talk on the "Economic and Operating Features of the Work," all of which are to be illustrated with moving pictures.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Convention, May 1-4, 1917, Memphis, Tenn.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago. Convention, June 13-15, 1917, Atlantic City, N. J.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—R. D. Fletcher, Belt Railway, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 Lawlor Ave., Chicago. Second Monday in month, except June, July and August, Hotel La Salle, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. R. McMunn, New York Central, Albany, N. Y. Convention, September, 1917, St. Louis, Mo.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, C., H. & D., Lima, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 547 W. Jackson Blvd., Chicago. Convention, May, 1917, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn. Convention, September 4-7, Hotel Sherman, Chicago, Ill.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York. Convention, May 22-25, 1917, Richmond, Va.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago. Convention, June 18-20, 1917, Atlantic City, N. J.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—E. N. Frankenberger, 623 Brisbane Building, Buffalo, N. Y. Meetings, third Wednesday in month, New York Telephone Bldg., Buffalo, N. Y.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, May 21-23, 1917, Chicago, Ill.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Mar. 13, 1917			James Powell	P. O. Box 7, St. Lambert, Que.
Central	Mar. 8, 1917	Annual Dinner; Address by Major-General G. W. Goethals		Harry D. Vought	95 Liberty St., New York.
Cincinnati	May 8, 1917			H. Boutet	101 Carew Bldg., Cincinnati, Ohio.
New England	Mar. 13, 1917	Annual Meeting, Election of Officers and Entertainment		Wm. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Mar. 16, 1917	Annual Electrical Night		Harry D. Vought	95 Liberty St., New York.
Pittsburgh	Mar. 23, 1917	Revision of Rules of Interchange	Committee	J. B. Anderson	207 Penn Station, Pittsburgh, Pa.
Richmond	Mar. 12, 1917			F. O. Robinson	C. & O. Railway, Richmond, Va.
St. Louis	Mar. 9, 1917	From Tree to Track	J. H. Waterman	B. W. Frauenthal	Union Station, St. Louis, Mo.
South'n & S'w'rn.	Mar. 15, 1917			A. J. Merrill	Box 1205, Atlanta, Ga.
Western	Mar. 19, 1917	Training of Men for Positions of Responsibility	F. W. Thomas	Jos. W. Taylor	1112 Karpen Bldg., Chicago.

PERSONAL MENTION

GENERAL

MORGAN KING BARNUM, superintendent of motive power of the eastern lines of the Baltimore & Ohio at Baltimore, Md., has been appointed to the new position of assistant to vice-president, with headquarters at Baltimore, Md., and he will give special attention to the conservation of material of all kinds, from stationery to locomotive and car material, and such as may be used for the maintenance of way and buildings; also to expand the work of reclamation and adopt such other plans as may be advisable in the use of materials and supplies. Mr. Barnum graduated from Syracuse University in 1884 with the degree of A. B., and later received the degree of A. M. He began railway work in 1884 as a special apprentice in the shops of the New York, Lake Erie & Western, now the Erie, at Susquehanna, Pa., and then, to September, 1887, served as machinist and mechanical inspector. He was then to 1889 general foreman of the same road at Salamanca, N. Y. From January to September, 1889, he was general foreman of the Louisville & Nashville at New Decatur, Ala., and then to September, 1890, was assistant master mechanic of the Atchison, Topeka & Santa Fe, at Argentine, Kan. From September, 1890, to the following June he was superintendent of shops at Cheyenne, Wyo., and then to December, 1898, was district foreman at North Platte, Neb., and later was master mechanic of the Nebraska division at Omaha, Neb., on the Union Pacific. From December, 1902, to February, 1903, he was assistant mechanical superintendent of the Southern Railway and from February, 1903, to April of the following year he was superintendent of motive power of the Chicago, Rock Island & Pacific. In June, 1904, he was appointed mechanical expert of the Chicago, Burlington & Quincy and left that road in April, 1910, to become general superintendent of motive power of the Illinois Central and the Yazoo & Mississippi Valley. In July, 1913, he was appointed general mechanical inspector of the Baltimore & Ohio and in September, 1914, was promoted to superintendent of motive power of the same road, which position he held at the time of his appointment to the new position of assistant to the vice-president, with headquarters at Baltimore, effective February 1.

M. K. Barnum

F. BENGER has been appointed acting engineer of tests at the Angus shops of the Canadian Pacific at Montreal, succeeding G. St. G. Sproule, temporarily a member of the Imperial Munitions Board.

W. D. DEVENY, master mechanic of the Arkansas River and Colorado divisions of the Atchison, Topeka & Santa Fe, with headquarters at La Junta, Colo., has been appointed mechanical superintendent, Southern district of the Western lines, with headquarters at Amarillo, Texas, succeeding A. Dinan.

R. G. BENNETT recently resigned as assistant master mechanic of the Cumberland Valley Railroad at Chambersburg, Pa., to become assistant engineer of motive power of the Pennsylvania Railroad with headquarters at Williamsport, Pa.

CHARLES A. GILL, general master mechanic of the Maryland district of the Baltimore & Ohio, at Baltimore, Md., has been appointed superintendent of motive power of the Eastern lines, with headquarters at Baltimore, succeeding M. K. Barnum, promoted.

H. HONAKER, master mechanic of the St. Louis-San Francisco at Memphis, Tenn., has been appointed assistant general superintendent of motive power with headquarters at Springfield, Mo.

W. L. KELLOGG, whose resignation as superintendent of motive power of the Missouri, Kansas & Texas at Dennison, Tex., has been noted previously, has been appointed superintendent of motive power of the Pere Marquette, with headquarters at Detroit, Mich., succeeding J. J. Walters, resigned to go with another company.

J. C. RAMAGE, formerly superintendent of tests of the Southern Railway, has been made superintendent of tests of the Southern Railway System. Mr. Ramage entered railroad service as inspector in the test department of the Baltimore & Ohio in 1890, remaining with that road in the test and mechanical engineering departments until November, 1895, when he went to the Southern Railway as chief inspector of the test department. He was promoted to superintendent of tests on April 1, 1897, serving in that capacity until his recent promotion.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

S. A. BRINSON has been appointed fuel supervisor of the Texas & Pacific, for the Fort Worth division, with office at Fort Worth, Texas.

A. B. DEASON has been appointed fuel supervisor of the Rio Grande division of the Texas & Pacific, with headquarters at Big Spring, Texas.

A. DINAN, heretofore mechanical superintendent of the Southern district of the Atchison, Topeka & Santa Fe, has been appointed master mechanic of the Panhandle division, with headquarters at Wellington, Kans.

F. W. DOUGLAS, chief engineer electrical department of the Atlanta Joint Terminals of the Louisville & Nashville, Atlanta & West Point and Georgia railroads at Atlanta, Ga., has been appointed master mechanic, in addition to his other duties, succeeding G. W. Eaves, resigned.

I. H. DRAKE, master mechanic of the Pecos division of the Atchison, Topeka & Santa Fe, with office at Clovis, N. Mex., has been appointed master mechanic at La Junta, Colo., succeeding W. D. Deveny.

JAMES T. EAGAN has been appointed assistant road foreman of engines of the Buffalo, Rochester & Pittsburgh, in charge of the territory between East Salamanca, N. Y., and Du Bois, Pa. Mr. Eagan entered the employ of the Buffalo, Rochester & Pittsburgh as fireman on July 6, 1892, and about five years later was promoted to engineer, which position he held up to the time of his recent promotion.

H. F. EMERSON has been appointed assistant road foreman of engines of the Pennsylvania Lines West, with office at Crestline, Ohio.

O. R. HALE, general master mechanic of the United Railways of Havana, at Havana, Cuba, has been appointed assistant superintendent of motive power of the Cuban Central Railways, with headquarters at Sagua La Grande, Cuba, effective February 1. Mr. Hale began railway work in

1888 as an apprentice in the machine shops of the Southern Pacific at Tucson, Ariz., and in 1904 went to Mexico as master mechanic of the Torreon division of the Mexican Central. He remained in that position until 1912, and then went to Havana as general master mechanic of the United Railways of Havana, which position he held at the time of his recent appointment.

A. K. GALLOWAY, formerly general master mechanic of the northwest district of the Baltimore & Ohio, at Cincinnati, Ohio, has been appointed general master mechanic of the Maryland district, succeeding Charles A. Gill, promoted.

C. W. HYDE, road foreman of equipment of the Chicago & Eastern Illinois, at Salem, Ill., has been appointed master mechanic of the Illinois division, with headquarters at Villa Grove, Ill., succeeding W. R. Meeder, resigned.

W. N. INGRAM, master mechanic, district 5, intercolonial division of the Canadian Government Railways at Edmundston, N. B., has been appointed master mechanic, district 4, Intercolonial division with headquarters at Stellarton, N. S., succeeding H. D. McKenzie, transferred.

CHRISTOPHER KELSO has been appointed acting master mechanic of the Grand Trunk at Stratford, Ont., during the absence of R. Patterson, who has become a member of the Imperial Munitions Board for the remainder of the war. Mr. Kelso was born in Liverpool, England, March 17, 1876. He came to Canada when 15 years of age, finishing high school at Kingston, Ontario, and subsequently entered the employ of the Canadian Locomotive Company, with whom he remained about ten years. He was then employed by the Canada Foundry Company at Toronto for three and a half years and began railroad work on September 2, 1909, with the Grand Trunk at Stratford, Ontario. Mr. Kelso recently completed the revising and installing of the present bonus efficiency system in force on the entire Grand Trunk system.

C. Kelso

WILLIAM MALTHANER, formerly superintendent of shops of the Baltimore & Ohio, at Newark, Ohio, has been appointed to succeed A. K. Galloway as general master mechanic of the Northwest district.

H. D. MCKENZIE, master mechanic, district 4, Intercolonial division of the Canadian Government Railways at Stellarton, N. S., has been appointed master mechanic, district 5, Intercolonial division, at Edmundston, N. B., succeeding W. N. Ingram, transferred.

A. E. MCMILLAN, master mechanic of the Baltimore & Ohio at Glenwood, Pittsburgh, Pa., has been transferred to Newark, Ohio, as master mechanic, succeeding W. F. Moran.

W. F. MORAN, master mechanic of the Baltimore & Ohio at Newark, Ohio, has been appointed master mechanic at Garret, Ind., succeeding F. W. Rhuark.

T. N. MURPHY has been appointed road foreman of engines on the Atchison, Topeka & Sante Fe, Middle division, with headquarters at Newton, Kans.

F. RONALDSON, heretofore district master mechanic, Farnham division, Quebec district, of the Canadian Pacific at Farnham, Que., has been appointed master mechanic, Ontario district, with office at Toronto, succeeding A. H. Kendall, enlisted for overseas service as captain in the battalion of skilled railway employees now recruiting.

H. H. STEVENS has been appointed master mechanic of the Pecos division of the Atchison, Topeka & Santa Fe, with headquarters at Clovis, N. Mex., succeeding I. H. Drake, transferred.

W. F. STOOPS has been appointed assistant road foreman of engines of the Pennsylvania Lines West, with headquarters at Conway, Pa.

D. H. VARNELL has been appointed fuel supervisor of the Texas & Pacific for the Louisiana division, with headquarters at Alexandria, La.

IRVING WILLIAMS has been appointed assistant master mechanic of the Cumberland Valley Railroad at Chambersburg, Pa., succeeding R. G. Bennett, resigned.

CAR DEPARTMENT

P. ALQUIST, superintendent of the car department of the Missouri, Kansas & Texas, with headquarters at Denison, Tex., has resigned to take a similar position with the Pere Marquette at Detroit, Mich., effective February 1.

A. E. CHESTERMAN has been appointed car foreman of the Canadian Pacific at Crowsnest, B. C., succeeding E. Tasker, transferred.

T. P. KLEAVER has been appointed foreman of the car department of the Missouri, Kansas & Texas, at Smithville, Texas, succeeding James A. Boggs.

E. TASKER, heretofore car foreman of the Canadian Pacific at Crowsnest, B. C., has been appointed car foreman at Field, B. C., succeeding M. J. Jordan, transferred.

SHOP AND ENGINEHOUSE

FRANK E. COOPER, formerly general foreman of the Baltimore & Ohio, at Newark, Ohio, has succeeded William Malthaner as superintendent of shops at that point.

PURCHASING AND STOREKEEPING

F. W. BOARDMAN, general mechanical inspector of the Texas & Pacific at Dallas, Tex., has been appointed fuel agent, reporting to the general manager.

T. FAWCETT, formerly assistant general storekeeper, Western lines of the Canadian Pacific at Winnipeg, has been appointed general storekeeper, Western lines, with headquarters at Winnipeg, succeeding L. O. Genest, deceased.

JOHN B. LIVINGSTON has been appointed storekeeper Western lines of the Grand Trunk, with headquarters at Battle Creek, Mich., succeeding John R. Crowell, deceased.

R. LORDAN has been appointed purchasing clerk of the Evansville & Indianapolis, with headquarters at Terre Haute, Ind.

H. P. MCQUILKIN, district storekeeper of the Southwest district of the Baltimore & Ohio and the Cincinnati, Hamilton & Dayton, at Cincinnati, Ohio, has been appointed chief clerk to the general storekeeper at Baltimore, succeeding A. R. Portlock, deceased.

R. D. QUICKEL has been appointed fuel agent of the Southern Railway, Lines West, with headquarters at Cincinnati, Ohio.

H. J. REED has been appointed division storekeeper of the St. Louis-San Francisco, with headquarters at Cape Girardeau, Mo., succeeding H. G. Cummins, resigned.

H. E. Rouse, general storekeeper of the Chicago Great Western, with headquarters at Oelwein, Iowa, has resigned to take a position in the purchasing department of the Mark Manufacturing Company, Chicago, Ill.

W. C. Ware has been appointed district storekeeper of Wheeling district and Newark division of the Baltimore & Ohio, succeeding H. Shoemaker, promoted.

W. G. Whiteley has been appointed acting storekeeper of the Grand Trunk Pacific at Transcona, Man., succeeding W. J. Sturgess, promoted.

OBITUARY

Archibald Buchanan, Jr., chief of equipment division in the valuation department of the New York Central at New York, died on February 5. He was born in New York City in 1870, and received his education in the public schools and Cooper Union. In 1890 he entered the service of the New York Central at West Albany, N. Y., as chief draftsman in the locomotive department, and later became foreman of the machine shop. From 1900 to 1903 he was master mechanic with the Delaware & Hudson at Green Island. He then went to St. Albans, Vt., as superintendent of motive power for the Central Vermont, returning to Albany in 1907 as chief of equipment division, with the Second district of the New York Public Service Commission. In 1913 he again entered active railway service as chief of equipment division in the valuation department of the New York Central Lines, with headquarters at Grand Central Terminal, New York.

John Hickey, mechanical engineer of the Salt Lake & Utah, died at Salt Lake City on February 3, 1917.

W. D. Minton, for the past 27 years master car builder of the Texas & Pacific, with headquarters at Marshall, Tex., died at his home in that city February 5, aged 69 years.

Henry Gordon Stott, superintendent of motive power of the Interborough Rapid Transit Company since 1901, died on January 16, 1917, at New Rochelle, New York.

Charles T. Turner, who was master mechanic at the Mount Clare shops, Baltimore, Md., of the Baltimore & Ohio, from 1903 to 1911, died on January 7, in Baltimore. Mr. Turner had been on the pension roll of the B. & O. since 1911, and prior to his retirement had been in the active service of the company for about 50 years.

James B. Wells, formerly road foreman of engines of the Middle division of the Pennsylvania Railroad, died at Harrisburg, Pa., on February 3, 1917. He was eighty-two years old and was retired in 1903, having served the company fifty-one years. He brought the first train through the Gallitzin tunnel.

NEW SHOPS

Oregon Short Line.—This company will erect a 5-stall addition to its roundhouse at Glenn's Ferry, Idaho.

Boston & Maine.—This company has given a contract to the H. Wales Lines Company, Meriden, Conn., to build a locomotive shop at East Deerfield, Mass. It will be of brick and steel construction 40 ft. high, 170 ft. wide, and 200 ft. long. The improvements will cost about $80,000.

Southern Ry.—Enlarged facilities for repairing cars at Spencer, N. C., will be constructed at once, to consist of a new all steel car shed 109 ft. by 600 ft. with a shop adjoining, 50 ft. by 100 ft. Bids are now being asked for the foundation work. The shed will be equipped with overhead cranes for handling car bodies and materials. Additional track room will be provided for handling the increased number of cars to be repaired.

SUPPLY TRADE NOTES

A. Hazelhurst has been appointed sales agent of the American Steel Foundries, with headquarters at Pittsburgh, Pa.

Cyrus J. Holland has joined the selling force of the Keyoke Railway Equipment Company, with headquarters at Chicago, Ill.

H. M. Green has been appointed railroad sales representative of the Barrett Company, New York, with headquarters at 1131 Reedsdale street, Pittsburgh.

Fred S. Hiland, formerly with the Patton Paint Company, Milwaukee, Wis., has been appointed a railroad representative for the Wadsworth-Holland Company, Chicago.

Thomas E. Litchfield, formerly with the railway department of the McCord Manufacturing Company Detroit, Mich., has resigned to enter the service of the Dayton Manufacturing Company, Dayton, Ohio.

C. C. Bradford, for several years sales manager of the U. S. Light & Heat Corporation, Niagara Falls, N. Y., has resigned from the company, effective January 1. Mr. Bradford has announced no plans for the future.

H. A. Matthews, manager of the sales-railway department of the U. S. Light & Heat Corporation, has transferred his headquarters from the Chicago branch office to the company's general offices at Niagara Falls, N. Y.

W. E. Kelly, representing the Patton Paint Company, Milwaukee, Wis., has been appointed district manager of railway sales, with headquarters at Chicago, Ill., succeeding F. S. Hiland, resigned, effective February 1.

Paul Judson Myler has been elected president of the Canadian Westinghouse Company, Ltd., of Hamilton, Ontario. H. H. Westinghouse, the retiring president, has been elected chairman of the board.

Charles H. Eib, for some time past a member of the sales force of the Republic Iron and Steel Company, Chicago, Ill., has been appointed manager of sales of the Chicago district, succeeding D. S. Guthrie, resigned to become affiliated with another company.

D. C. Thomas, superintendent of small supplies in the purchasing department of the Atchison, Topeka & Santa Fe, has been appointed sales representative of the Barco Brass & Joint Company, of Chicago, in western territory, with headquarters at Kansas City, Mo.

H. A. Hoffman, formerly with the General Electric Company (steam flow meter department), has been placed in charge of the Philadelphia branch office of the Lagonda Manufacturing Company of Springfield, Ohio, with office in the Pennsylvania building.

The Gulick-Henderson Company, consulting and inspecting engineers and owning physical and chemical laboratories, announces the removal and consolidation of its general offices from 30 Church street and 120 Broadway to 13-21 Park Row, New York, suite 1932 to 1939.

William Berdan, at one time secretary and treasurer of the Cooke Locomotive Works, since made a part of the American Locomotive Company, and for the past 20 years vice-president of the Paterson Safe Deposit & Trust Company, died at his home in Paterson, N. J., January 21, aged 68 years.

The Modern Tool Company, Erie, Pa., manufacturers of the line of "Modern" grinding machines and threading tools, announces that H. L. Harrison has joined its mechanical staff, with the position of factory manager. Mr. Harrison

was formerly connected with the Packard Motor Car Company, the Maxwell Briscoe Company, and the American Car & Foundry Company.

Thomas Wyatt Gentry, for many years southern sales representative of the American Locomotive Company, died January 8 at his home in Richmond, Va. He was 66 years old, having been born September 19, 1850. He was at one time master mechanic on the Richmond & Danville, now part of the Southern Railway, and entered the employ of the American Locomotive Company in 1893.

The Ryan Car Company, Chicago, Ill., has just acquired about 50 acres of land a short distance from its present plant in that city for the purpose of building a plant for the manufacture and repair of all-steel freight cars. The company's present plant will continue to be used for the manufacture and repair of both wooden and steel cars. It is estimated that the improvements in the way of new buildings, machinery and other facilities will be between $300,000 and $400,000.

William M. Bailey has been appointed assistant to A. C. Dinkey, president of the Midvale Steel Company, Cambria Steel Company, Worth Brothers Company and Wilmington Steel Company, effective February 1. Mr. Bailey will have charge of accidents and workmen's compensation, safety and welfare, labor, real estate and housing, police, insurance, contributions and such other matters as may be assigned to him. He will be in charge of organizing an entirely new department of the combined companies. Mr. Bailey was formerly secretary to Mr. Dinkey.

General George W. Goethals announces that he has opened consulting offices in the Wall Street Exchange building, 43 Exchange Place, New York. He has associated with him experienced specialists, and will engage in a general consulting practice in civil, electrical, mechanical and hydraulic engineering. Special attention will be given to examinations and reports on canals, harbors, dry docks, terminals, dams, water power development, water supplies, purification of tropical waters, refrigeration, reinforced concrete structures, organizations, management and public utilities.

Colonel Herbert Hughes, C. B., C. M. G., of Sheffield, Eng., a director of the firm of William Jessop & Sons, Inc., New York, died recently in England at the age of 64 years. Colonel Hughes was lord mayor of Sheffield in 1905-1906, and was prominently associated with the volunteer forces in England. He was at one time a member of the Advisory Board at the War Office. He represented the British government at the International Conference on Trade Marks, held at Washington, D. C., a few years ago. He was well known in legal and commercial circles in New York and at Washington.

The United States Metallic Packing Company, Philadelphia, announces that after a long legal contest its patent No. 914,426, dated March 9, 1909, for the King ring, has been sustained by the United States circuit court of appeals for the seventh circuit, and that the supreme court of the United States has refused the petition of the Hewitt Company that it should review the action of the court of appeals. The company's patent is now definitely established, as is also the fact that the Hewitt Company's ring, the further manufacture of which its suit was brought to stop, is an infringement of its rights.

Edward Weldin Grieves died recently at his home in Baltimore. Mr. Grieves was born in Wilmington, Del., in 1843, and educated in private and public schools of Wilmington. For many years he was superintendent of the car plant of Harlan & Hollingsworth, at Wilmington, which position he relinquished in 1884 to take the superintendency of car building for the Baltimore & Ohio at Baltimore. Mr. Grieves left the Baltimore & Ohio in 1898 to become mechanical expert for the Galena Oil Company and president of the Farlow Draft Gear Company. He retired from active business two years ago.

Joseph Davis, vice-president and controller of the American Locomotive Company, was formerly controller, which position he has held since 1909. Mr. Davis was born in New York in 1875. He attended high school at Albany, N. Y., and was for three years associated with the controller's office of the Delaware & Hudson at Albany. He later spent three years in the accounting department of the New York Central at New York and then left railway service to run a ranch in Colorado. He entered the service of the American Locomotive Company in 1901 in the accounting department and became controller in 1909.

L. L. Cohen, lately connected with the Safety First Manufacturing Company of Chicago, Ill., and prior to that, western sales representative of the Johns-Manville Company, with headquarters at Salt Lake City, Utah, and also Denver, Colo., has been elected president of the Union Supply Company, with offices at 112 West Adams Street, Chicago, Ill. He succeeds L. Mosier, retired on account of poor health. The Union Supply Company handles products of the Bryant Manufacturing Company, Globe Metal Company, William B. Anderson Foundry Company, Central Steel & Supply Company and the Wine Railway Appliance Company.

Harry B. Hunt, who has been elected assistant vice-president in charge of manufacture of the American Locomotive Company, has been with the company eight years. He was born in New York and graduated from the Massachusetts Institute of Technology in 1897. He spent eight years in the operating and mechanical departments of the Erie Railroad and held the positions successively of mechanical engineer, assistant mechanical superintendent and assistant to the general manager. Since he has been with the locomotive company he has served in the manufacturing, engineering and sales departments, and now returns to the manufacturing department from the sales department.

The American Car Roof Company, Chicago, announces that it has given the following car building companies shop rights to build and apply the Christy roof to freight cars when specified by railway companies: The American Car & Foundry Company, the Cambria Steel Company, the Haskell & Barker Car Company, the Mount Vernon Car Manufacturing Company, the Pressed Steel Car Company, the Pullman Company, and the Standard Steel Car Company. The car builders will absorb the royalty charge, remitting to the American Car Roof Company for the number of roofs built. The Christy roofs are of two types, the all-steel and the insulated steel.

Columbus K. Lassiter, the newly elected vice-president of the American Locomotive Company, in charge of manufacture, has been in the service of the company or its predecessors for twenty-two years. He entered the service of the Richmond Locomotive Works as chief clerk to the president of that company. He was later transferred to the American Locomotive Company's plant at Schenectady (about 1904) and served as mechanical expert for about six years, during the reconstruction of the plant. About seven years ago he came to New York as general mechanical superintendent, and at the outbreak of the European war was also appointed a member of the ordnance committee.

Alexander R. McAlpine, special representative of Bird & Son, died at his home in Chicago on January 14. Mr. McAlpine was born at North Framingham, Mass., in 1850, and went west when he was 20 years old, going to the Bee Line, now a part of the Big Four. During his 15 years with that road he was master mechanic and master car builder. In 1885 he went to the Western Car Company as superintendent. After 15 years with that company he went with the Burton Stock Car Company, and in February, 1902, with

Bird & Son. Mr. McAlpine was well known in the railroad field in and about Chicago, and was actively connected with the Car Foremen's Association of Chicago for several years.

The Combustion Engineering Corporation, 11 Broadway, New York City, announces the doubling of the size of its New York offices. This change was made to accommodate the increase in business due to the constantly increasing demand for its Type "E" stoker for bituminous coal, and the Coxe stoker for anthracite coal. With the enlargement of its offices, this company has added considerably to its staff of draftsmen and engineers. It further announces the organization of six additional erecting units, each under the direction of a superintendent for field work, and the establishment of a service department under the direction of John Morris, who has been associated with the company since its organization.

James D. Sawyer, recently elected vice-president of the American Locomotive Company, in charge of sales, has been in the service of the company or its predecessors since 1898 and its manager of sales since 1907. He was born at Buffalo, N. Y., in 1875. He graduated from Yale in 1896 and entered the employ of the Brooks Locomotive Works at Dunkirk, N. Y., in August, 1898. He worked in various departments until in 1901, when the American Locomotive Company was formed, he became assistant to the second vice-president in charge of sales, with office at Dunkirk. He was transferred to New York in 1904 in the same capacity and held that position until 1907, when he was appointed manager of sales.

Pratt & Lambert, Inc., varnish makers, Buffalo, N. Y., have elected the following officers and directors for the coming year: W. H. Andrews, chairman of the board; J. H. McNulty, president; J. N. Welter, vice-president; J. B. Bouck, Jr., secretary and treasurer; A. C. Bedford, C. M. Pratt, F. W. F. Clark, R. F. Clark, S. N. Griffiths and J. P. Gowing, directors. On January 3 the sales force of the company held its biennial convention at Buffalo. This convention marked the completion of the president's twenty-fifth year with the company. About 75 salesmen and executives attended the meetings and discussed new developments in the chemistry of varnish-making and better methods of marketing the firm's products. F. W. F. Clark, retiring vice-president, made the trip from his home in London, Eng., to attend the convention.

E. W. Richey, who has been elected vice-president of the Standard Forgings Company, Chicago, Ill., was born at Richmond, Ind., on June 10, 1876. He entered railway service with the Vandalia at St. Louis, Mo., in September, 1893. In June, 1896, he became connected with the Chicago Terminal Transfer, and the following month he went with the Duluth, Missabe & Northern at Duluth, Minn. He was with the Union Elevated Railroad of Chicago from October, 1897, until September 1903, when he became general sales agent and secretary of the Standard Forgings Company. On March 1, 1914, he was appointed assistant to the president of A. M. Castle & Company, Chicago, and on August 1, 1916, resigned to become assistant to the president of the Standard Forgings Company, which position he held at the time of his election to the vice-presidency, as noted above.

The National Railway Appliance Company, a new concern, incorporated for the purpose of selling railway supplies, announces that it has taken over the entire railroad department business of the U. S. Metal & Manufacturing Company. The new company will have temporary offices at 165 Broadway, New York City, and the officials elected to carry on the affairs of the concern are as follows: President, B. A. Hegeman, Jr.: first vice-president, Charles C. Castle; vice-president and treasurer, Harold A. Hegeman; assistant to president, F. C. Dunham; secretary and engineer, Edward D. Hillman. The company has established a branch office in the McCormick building, Chicago, under the immediate management of Walter H. Evans, and a branch office in the Munsey building, Washington, D. C., under the management of J. Turner Martyn. Both managers were formerly connected with the railroad department of the U. S. Metal & Manufacturing Company.

The General Roofing Manufacturing Company of St. Louis, Mo., has announced that it purchased the Mound City Paint & Color Company and the Gregg Varnish Company, both of St. Louis, and the Lockport Paper Company of Niagara Falls, N. Y., on February 1. A new corporation, including these companies, has been organized, and will be known as the Certain-teed Products Corporation. The new company is capitalized at $25,000,000. The following officers were elected: George M. Brown, president; Smith E. Allison, New York City; Audenried Whittemore, Chicago; J. S. Porter and J. F. Schlafly of St. Louis, vice-presidents; J. C. Collins of St. Louis, secretary and treasurer, and Clinton Brown, assistant secretary and treasurer. All formerly were officials of the General Roofing Manufacturing Company. While the General Roofing Manufacturing Company already has offices in nearly all the large cities, new offices will be opened in Buffalo, N. Y.; Milwaukee, Wis., and Salt Lake City, Utah. The headquarters will remain in St. Louis, as at present.

The Westinghouse Electric & Manufacturing Company announces that the plot of ground recently purchased at Essington, near Philadelphia, will form a new industrial center for the Westinghouse Electric interests. The site embraces about 500 acres, with a frontage of approximately one mile on the Delaware River. Additional transportation facilities will be afforded by tracks from the Pennsylvania and Philadelphia & Reading Railroads. This new center will be devoted to the production of large apparatus, the first group of buildings being for power machinery, principally steam turbines, condensers and reduction gears. The initial development will cost in the neighborhood of $5,000,000 or $6,000,000, occupying about one-fifth of the area of the entire plot. The group will consist of the following buildings: two large machine shops, an erecting shop for heavy machinery, forge shop, pattern and pattern-storage shop, and power house. Work will begin on these as soon as satisfactory building contracts can be let. The number of employees to be engaged at the new plant has not as yet been definitely determined, but will number several thousand people, and undoubtedly will in the future equal the number employed at East Pittsburgh, representing over 20,000 people.

Charles T. Schoen, the inventor of the pressed steel car, and at one time president of the Pressed Steel Car Company, died at his home in Moylan, near Philadelphia, February 4, aged 72 years. Mr. Schoen was born in Delaware and was educated in Wilmington. He worked there with his father, Henry Casper Schoen, in whose shops he learned the cooper's trade. He later removed to Philadelphia to assume a position with Charles Scott, who was engaged in the manufacture of car springs. He later developed pressed steel equipment and fittings for wooden freight cars, including car trucks, and finally the complete steel car. The first company to manufacture his steel car was known as the Schoen Pressed Steel Company, incorporated in 1895. In 1899 a combination of this company and the Fox Pressed Steel Equipment Company, which two companies then controlled practically all the pressed steel car business in the country at the time, brought about the Pressed Steel Car Company, of which Mr. Schoen was president until his retirement in 1902. Mr. Schoen was also the inventor of a solid forged and rolled steel car wheel and was head of the Schoen Steel Wheel Company. After his retirement as president of the Pressed Steel Car Company he became chairman of the board of di-

rectors of the company. He was also vice-president of the Colonial Trust Company, of Philadelphia.

H. A. Gray, assistant manager of railroad sales of Joseph T. Ryerson & Son, in charge of eastern territory, has been appointed manager of sales of the railroad department of that company, with headquarters in Chicago. Mr. Gray has been in the service of Joseph T. Ryerson & Son for 16 years. He was born at Alton, Ill., November, 1878, and received his education at the high schools of Evanston, Ill., and at St. Paul's School, Concord, N. H. He entered the service of Joseph T. Ryerson & Son in 1901, and was connected with various departments of the business, both in Chicago and New York. He became associated with the railroad department in 1913, and in March, 1916, was appointed assistant manager of railroad sales.

H. A. Gray

W. F. M. Goss, dean of the college of engineering and director of the engineering experiment station of the University of Illinois, has resigned to become president of the Railway Car Manufacturers' Association, effective March 1. This association is an organization of fifteen manufacturers of freight and passenger cars in this country, including the American Car & Foundry Company, the Barney & Smith Car Company, the Bettendorf Company, the Cambria Steel Company, the Haskell & Barker Car Company, the Harlan & Hollingsworth Corporation, the Keith Car Company, the Laconia Car Company, the Middletown Car Company, the Mount Vernon Car Manufacturing Company, the Osgood-Bradley Car Company, the Pressed Steel Car Company, the Pullman Company, the Ralston Steel Car Company, and the Standard Steel Car Company.

The organization has been in existence for several years, but the officers and members have been unable to give due attention to it on account of pressing duties to their own companies. This led to the election of Dr. Goss as president, who will devote his entire time to furthering the purposes of the association. Among the studies he will make in his new work will be the adaptation of cost accounting to the needs of car manufacturers, the prevention of fires and accidents in car plants, and standardization of the design of cars, or parts of cars, the standardization of car specifications, and ways and means of establishing a greater degree of co-operation between the car builders and the railroads to their mutual advantage. A further economy, which it is believed he will effect, will be to prevent the duplication of experimental work by different car builders. If pending congressional legislation is passed legalizing the co-operation of car manufacturers in the promotion of foreign business, Dr. Goss will investigate the best methods of developing that field. In matters of common concern to the railroads and manufacturers relating to car construction, he will have full authority to co-operate with the railways and to give them as much assistance as possible.

The other officers chosen by the association are: Vice-president, J. M. Hansen, president of the Standard Steel Car Company; secretary and treasurer, William Bierman, secretary of the Standard Steel Car Company; executive committee, Mr. Hansen, F. H. Hoffstat, the Pressed Steel Car Company; W. H. Woodin, president American Car & Foundry Company, and J. S. Ralston, president of the Ralston Steel Car Company.

Charles Haines Williams, of the Chicago Railway Equipment Company, Chicago, was elected first vice-president of the company at its recent annual meeting. Mr. Williams was educated in the public schools of Baltimore, Md., and at the Baltimore Polytechnic Institute, from which he graduated in 1893, and also took a special course in mechanical drawing and machine design at the Maryland Institute. He spent four years as special apprentice in the Mount Clare shops of the Baltimore & Ohio, working in the machine and locomotive shops, the erecting shops and in the foundry, drawing room and test departments. He left the Baltimore & Ohio to become connected with the Chicago Railway Equipment Company as mechanical inspector, and has been with that company since.

C. H. Williams

George Henry Hill, assistant engineer of the railway and traction department of the General Electric Company, died of pneumonia at his home in Schenectady, January 31. Many important developments in the application of electric power to new uses owe their success to Mr. Hill's efforts. Early in his career as an engineer, he invented and patented the electric system for operating bulkhead doors on shipboard, which many years ago was standardized by the navy department for United States naval vessels and is used on commercial and naval vessels in many parts of the world; later he assisted in the development of the multiple unit system of train control, and in connection with this work produced the multiple unit automatic system substantially as it exists today. During the past few years Mr. Hill devoted considerable time to the electrification of steam railroads and has been an active supporter of high voltage direct current for interurban railways and for steam trunk line electrifications. More recently he was engaged in exhaustive studies of the interference of transmission and railway feeder lines with telephone and telegraph circuits.

G. H. Hill

Mr. Hill was born at Williamsport, Pa., on December 11, 1872, where he attended the local preparatory schools and Dickinson Seminary. After completing his preparatory work, he entered Johns Hopkins University, graduating from the electrical engineering course in 1895. Immediately upon graduation he became associated with Frank J. Sprague, who was at that time engaged in the development of elec-

trically operated elevators and multiple unit control for railway service. He was advanced rapidly and soon became chief of construction of the elevator department, with his office in New York City. When the Sprague Electric Company gave up its elevator business in 1900 he became chief engineer for the company at Bloomfield, N. J., and was directly responsible with Mr. Sprague for the development of multiple unit control for railway trains.

In 1902 the Sprague patents and interests were taken over by the General Electric Company, and Mr. Hill went to Schenectady to follow the further development of train control. Within two years he had become assistant to F. E. Case in supervision of all train control for the General Electric Company, directing the important steps in the manufacture of car equipments for the Manhattan Elevated in New York, the Boston Elevated, Baltimore & Ohio electric locomotives and later equipments for the Interborough Rapid Transit, the Northwestern Elevated and the Philadelphia Rapid Transit Company. The equipment of the New York Central electric locomotives was also under construction at this time, together with many equipments for foreign countries, including England, France, Italy, Cuba and Peru.

In 1906 Mr. Hill became assistant engineer of the railway and traction department in charge of the group of engineers dealing with the general problems arising in connection with electric railway apparatus and engineering. In this position his ability and experience were invaluable and he was one of the company's most important advisors, aiding in the solution of many difficult problems connected with the railway industry. Articles from his pen on railway subjects have frequently appeared in the technical press and in the proceedings of the American Institute of Electrical Engineers, of which he was an active member. During his active career, Mr. Hill made many inventions, both in the railway and other electrical fields, and between 40 and 50 patents were granted to him.

M. C. M. Hatch, superintendent of fuel service of the Delaware, Lackawanna & Western, has resigned to accept a position as assistant to the president of the Locomotive Pulverized Fuel Company of New York. Mr. Hatch was born in Chelsea, Mass., in 1882. He attended the public schools in that city and in Boston, and spent two years in the Massachusetts Institute of Technology, and two years at the University of California, in the latter institution taking the course in mechanical engineering as a member of the class of 1903. He then spent about 18 months in the shops of the Southern Pacific at West Oakland and Sacramento, Cal., followed by six months in the test department, and six months in the signal department of the same road. In June, 1905, he returned East and went to work in the mechanical department drafting room of the Boston & Maine. He remained with that company until October, 1911, serving during the last five years of that period as chief draftsman. From October, 1911, to April, 1912, he was engineer of tests of the New England lines, that is, of the New Haven, Boston & Maine and the Maine Central. In April, 1912, as above noted, he became superintendent of fuel service of the Delaware, Lackawanna & Western.

M. C. M. Hatch

Catalogues

Wrought Iron Pipe.—The A. M. Byers Company, Pittsburgh, Pa., recently issued Bulletin No. 27, which contains reprints of letters from users of their products.

Tool Steel.—A folder recently issued by the Vanadium-Alloys Steel Company, Pittsburgh, Pa., deals with the company's Vasco special, Vasco electric and Vasco Latrobe carbon tool steels.

Tin Plate.—The American Sheet & Tin Plate Company, Pittsburgh, Pa., has issued an attractive 28-page booklet, No. 120, entitled "Black Sheets and Special Sheets." The booklet describes the various kinds of tin plate made by the company and contains a number of tables, among them being one of weights of American painted roofing and siding, a bundling table of black sheets, etc. Another of the interesting features of the booklet is a diagram of the manufacture of steel showing the processes from the ore, limestone and coal to fabricated structures, rails, frogs and switches, wire and nails, tin plate, etc.

Engine Lathes.—Hill, Clarke & Co., Inc., Boston, Mass., have issued a circular describing the Roulsted 20 in. engine lathe. This lathe is for heavy duty work and has a three-step driving cone for 4-in. belt and double back gears. Eighteen spindle speeds are available, ranging from 7 to 285 revolutions per minute. The semi-quick change gear box gives six changes of geared feeds at the touch of a lever. The apron is of the double plate type and has reverse for all feeds, operating independently of the all steel tumbler reverse in the headstock. The lathe has an actual swing over the bed of 21 in. and on a 10 ft. bed takes 5 ft. 3 in. between centers. The net weight is about 4,900 lb.

Arc Welding.—This is the title of an interesting and attractive book recently issued by the Arc Welding Machine Company, New York. This company has been formed to market the materials and machinery and the welding practice which has been developed by the Electric Welding Company, organized in New York in 1908. The booklet contains data illustrated by some very interesting line drawings, showing the greater efficiency of electric arc over gas welding, particularly as to the greater concentration of the former. The methods of securing proper welding and heat treating are brought out. One section deals with electric arc control and several pages are devoted to the closed circuit system.

Dust Guards.—A most attractive and well illustrated 16-page booklet, recently issued by the Virginia Equipment Company, Toledo, Ohio, details the advantages of proper journal lubrication, and shows how this can be assisted by the use of Virginia Compound Compensating Dust Guards. The pamphlet is in the form of a treatise. The author of it has shown just how much in actual money a railway can lose by using poorly made dust guards, both through additional journal turning and in losses in power by poorly lubricated journals. He shows further that the ordinary wooden and tin dust guard is not efficient, for it does not prevent sand from getting in the journals, nor does it permit proper packing of the journal box. He then goes on to show the advantages of the Virginia Compensating Dust Guard. This guard is built up of layers or piles of wood, placed with the grain running at right angles and cemented and riveted together under heavy hydraulic pressure. It is made in two segments, and so arranged that the compensating devices keep them in positive contact with the axle. Through this arrangement the wear is automatically taken up, the ingress of dust prevented, and there is insured a positive, dustproof resilient contact with the axle at all times.